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LITERATURE

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Compressed Air Magazine

PHOTO, LOS ANGELES DEPARTMENT OF WATER AND POWER

CHRISTENING OF NEW RESERVOIR

First Water from Colorado River Enters Eagle Rock Basin in Los Angeles

VOLUME 58 • NUMBER 12 NEW YORK • LONDON

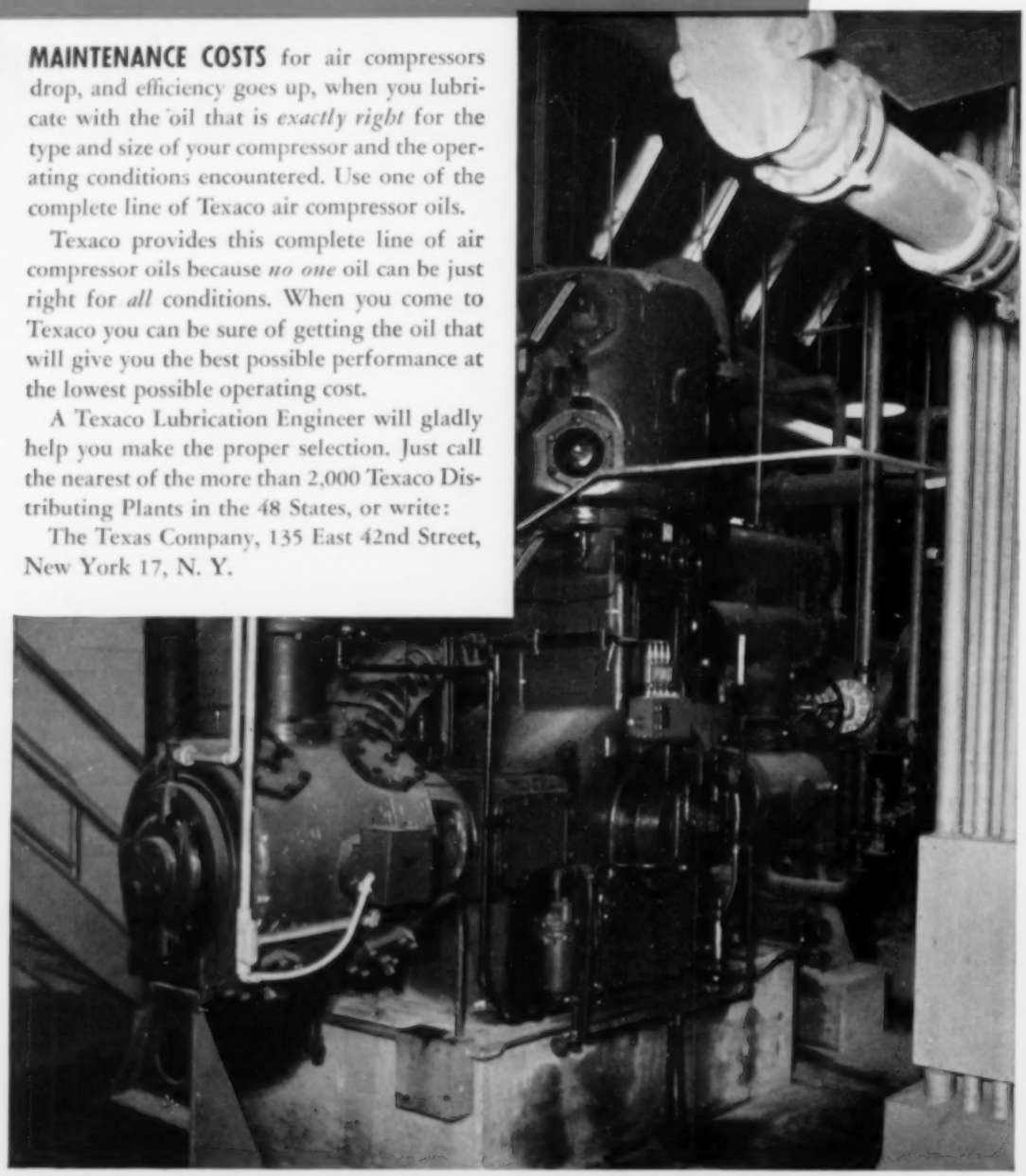
HOW TO RUN YOUR COMPRESSORS FOR LESS . . .

MAINTENANCE COSTS for air compressors drop, and efficiency goes up, when you lubricate with the oil that is *exactly right* for the type and size of your compressor and the operating conditions encountered. Use one of the complete line of Texaco air compressor oils.

Texaco provides this complete line of air compressor oils because *no one* oil can be just right for *all* conditions. When you come to Texaco you can be sure of getting the oil that will give you the best possible performance at the lowest possible operating cost.

A Texaco Lubrication Engineer will gladly help you make the proper selection. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.



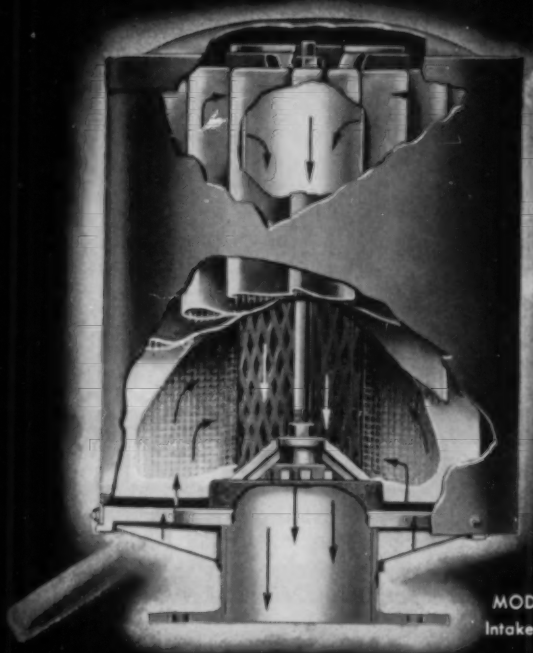
TEXACO

TEXACO Air Compressor Oils

FOR ALL OPERATING CONDITIONS

TUNE IN . . . METROPOLITAN OPERA radio broadcasts every Saturday afternoon. See newspaper for time and station.

YOUR EQUIPMENT WILL LAST LONGER with STAYNEW INTAKE FILTERS!



MODEL D
Intake Filter

AND HERE'S WHY! Your equipment needs the protection Staynew Intake Filters are designed to give. Staynew Intake Filters stop the dust and dirt from entering through air intakes. Staynew's *Positive Protection* keeps shutdowns and repairs at an absolute minimum, actually lengthening equipment life. And Staynew itself requires less attention than ordinary intake filters, frequently operating two or more years *without maintenance.*

Write today for catalog S. I. F.

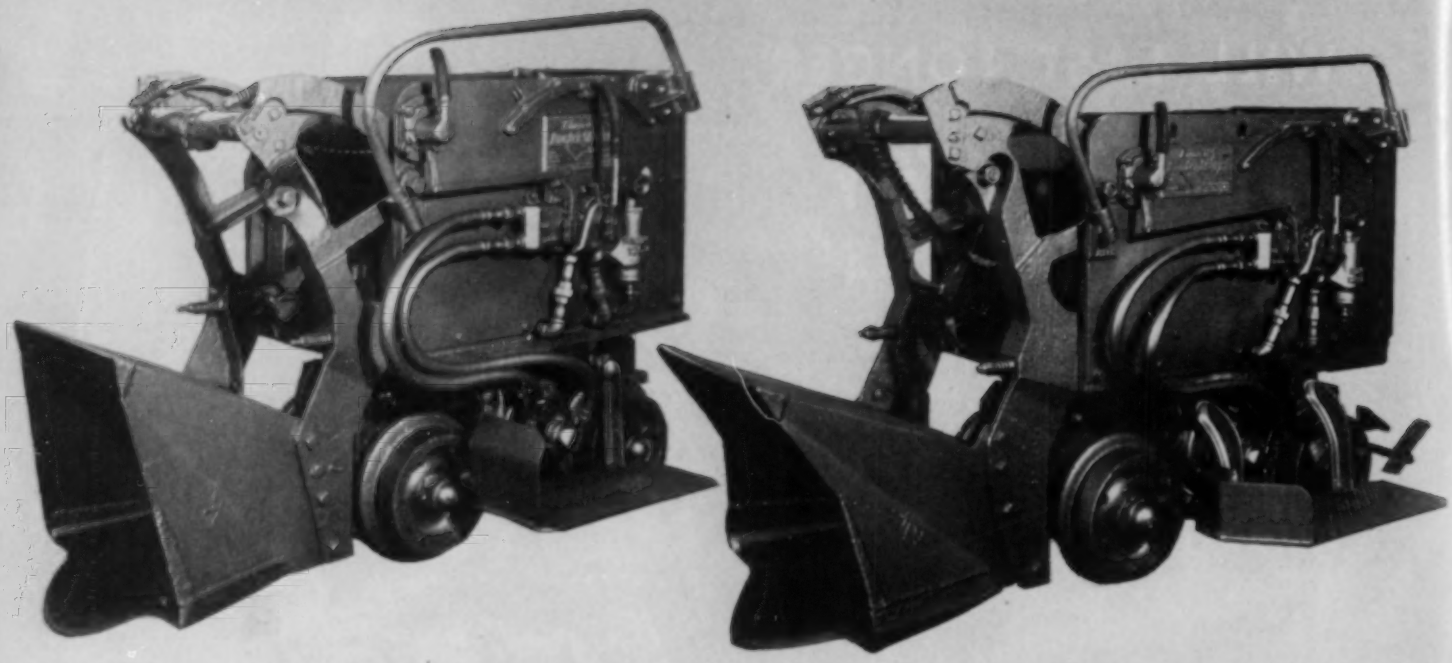
DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

Representatives in Principal Cities

DOLLINGER CORPORATION

7 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



SPECIALIZED EQUIPMENT SAVES IN LOADING - GRINDING AND FILTRATION

The efficient operation of New Jersey Zinc through the years can be in part attributed to the exacting requirements of their management and supervisory personnel in the type of equipment purchased.

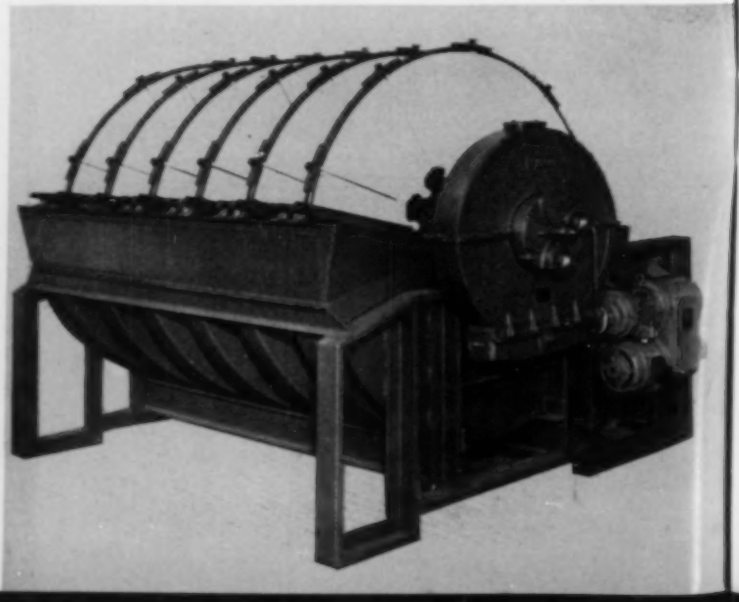
Their selection of Eimco equipment for many special jobs in all the various operations of this great company is indeed gratifying to us as producers of mining and processing equipment.

Their operations are using Eimco equipment that has been working steadily for 10 to 12 years and doing a good job because successful operations such as these will tolerate nothing else.

Eimco equipment in use for various purposes includes four models of Rocker Shovels used for exploration development and production mining. Mechanical loading in production mining as used in some of their properties is "old stuff" to New Jersey Zinc but is still comparatively new to the general mining public who still argue chutes and grizzlie versus mechanical loading from draw points. Eimco continuous disc type filters and ball mills form an important part in the flow sheet of several of the milling operations. These units were also scrutinized carefully for their efficient operation and have proven satisfactory.

Other important mining operations across this country and indeed in every mining country of the world have found that Eimco equipment serves best where heavy-duty dependable service is desired.

When you have a problem in loading or filtration, let Eimco Engineers help you—no obligation, of course.



EIMCO

THE EIMCO CORPORATION
Salt Lake City, Utah, U.S.A.
Export Office, Eimco Bldg., 52 South St., New York City

AV-7

GM DIESEL
CASE HISTORY No. 639-51

USER: Geo. M. Brewster & Son, Inc., Bogota, N. J.

INSTALLATION: Four GM Diesel-powered Ingersoll-Rand Gyro-Flo 600 compressors supplying air for 9 I-R 71 wagon drills.

PERFORMANCE: "Completely satisfactory," says operator Tom Malone. Units shown were delivering air to the tools through 1200 to 1600 feet of line--maintaining steady pressure of 100 to 110 psi.

It pays to STANDARDIZE on

GM
GENERAL MOTORS
DIESEL
POWER

2400 CUBIC FEET OF AIR PER MINUTE ON NEW YORK THRUWAY ROCK CUT

Geo. M. Brewster & Son now operate a total of 18 General Motors Diesel-powered Gyro-Flo compressors, including this battery of four capable of supplying 2400 cubic feet of air per minute for rock drills on a section of the New York Thruway, near Kingston.

These modern rotary compressors take full advantage of GM Diesel's smoother-running 2-cycle operation to maintain a steady flow of nonpulsating air at 100 psi or better. And compactness of the GM 2-cycle design makes these units smaller and lighter for quick, easy movement from job to job.

This inherent engine design superiority—plus interchangeability of lower-cost parts, readily available through a world-wide GM Diesel service organization—explains why GM Diesel power is a favorite of contractors on so many jobs. Next time you order equipment, it will pay you to specify GM Diesel. Available as original or replacement power in more than 750 different models of equipment. Write us for complete list.

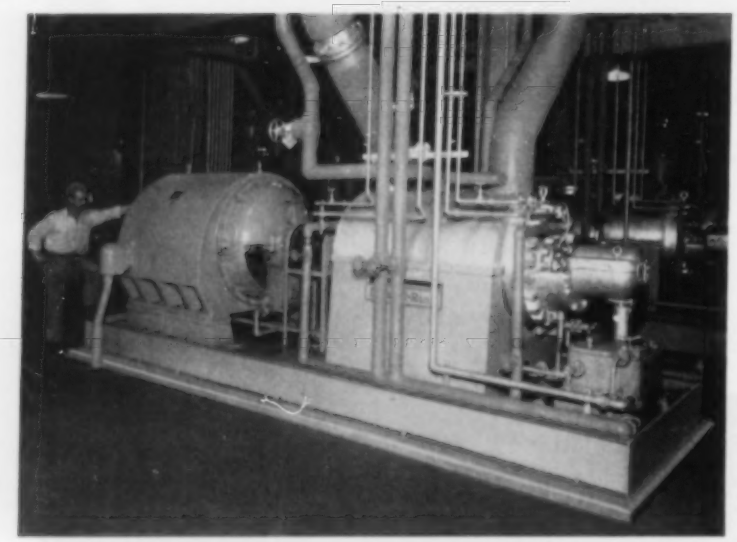
DETROIT DIESEL ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN
Single Engines . . . 16 to 275 H.P. Multiple Units . . . Up to 840 H.P.

Contributing to the

of New England Electric System's

Ingersoll-Rand

CONDENSERS AND ACCESSORIES
BOILER FEED PUMPS
GENERAL SERVICE PUMPS
SOOT BLOWING COMPRESSORS



One of six Ingersoll-Rand 9-stage double-case boiler feed pumps serving the Salem Harbor Station. A 4th stage take-off delivers 778 gpm at 2170′ total head for attemperating service. The last 5 stages deliver 730 gpm at 2620′.

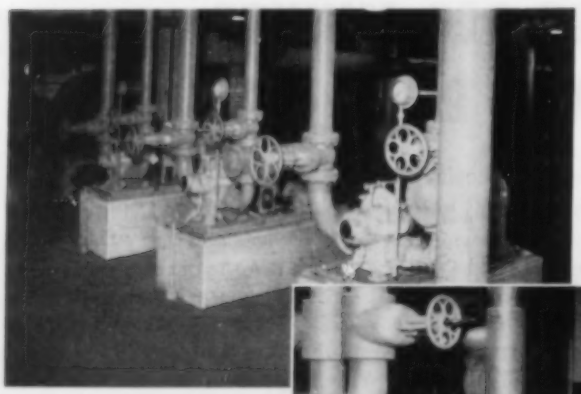
New England Electric System's Salem Harbor Station at Salem, Mass. is a fine example of the best in modern central station design. New England Power Service Company and United Engineers and Constructors, Inc. collaborated on the station's design, the latter firm doing the construction.

This station combines high operating economy with maximum continuity of service. That calls for *proved* economy and dependability in every item of equipment in this 150,000 kw plant.

That's why Ingersoll-Rand is pleased to have been called on to supply so much of the auxiliary equipment serving both units at Salem Harbor Station. Major items of this equipment are shown in the accompanying photos.

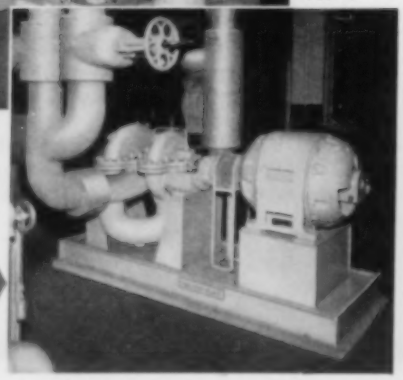
For *dependability*, operating economy and low maintenance, it pays to install Ingersoll-Rand central station auxiliaries.

Ingersoll-Rand
Cameron Pump Division
11 Broadway, New York 4, N. Y.



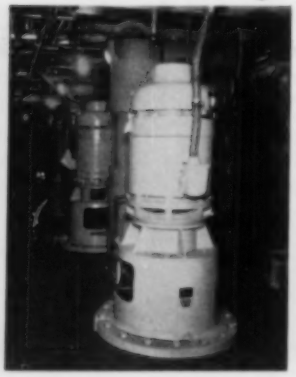
955-10

Three I-R single-stage general service pumps supply cooling water for various station equipment.

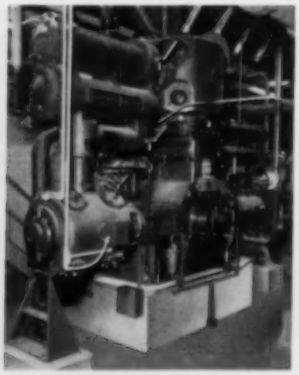


This I-R two-stage pump, rated at 1500 gpm and 270′ total head, is on city water booster service.

Two I-R two-stage, vertical turbine pumps handling service water.

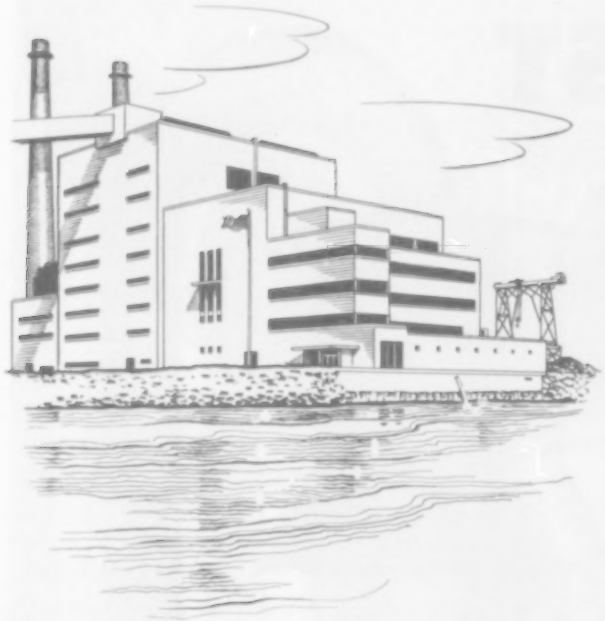


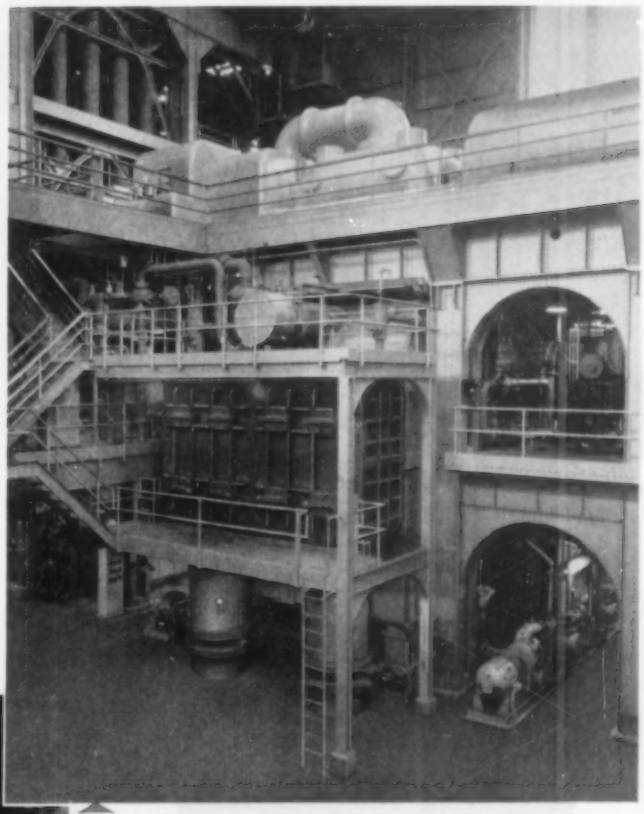
One of three I-R Class TVH 3-stage, 500 psi soot blowing compressors.



Dependability

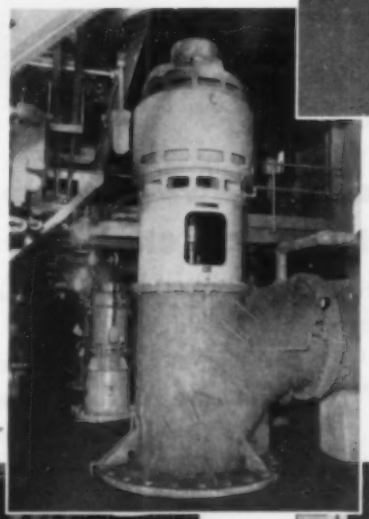
SALEM HARBOR STATION





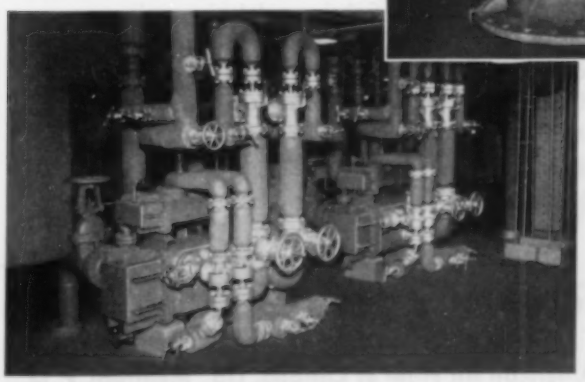
Unit 2 of the Salem Harbor Station, showing the 47,500 sq. ft. I-R rectangular steam condenser under the 75,000 kw turbo-generator. A duplicate condenser serves Unit 1.

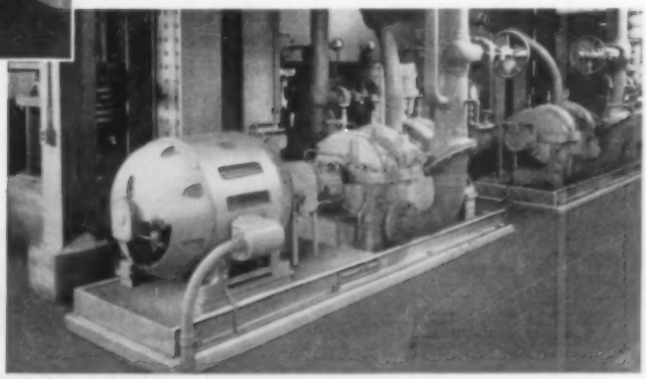
One of four I-R single-stage vertical condenser circulating pumps which each deliver 54,000 gpm to the condensers at Salem Harbor.



These two-stage steam jet air ejectors remove non-condensables from the steam condenser for Unit 2.

Two of the four I-R horizontal condensate pumps which serve the two condensers at the Salem Harbor Station. Each pump is rated 1,000 gpm, 465' total head and 1180 rpm.





CYCOIL PRESENTS "SOLID FRONT" AGAINST DUST

Compressor station of El Paso Natural Gas, Farmington, N. M. Air intakes to each of four 1350 H. P. Cooper-Bessemer units equipped with Cycoil Oil Bath Air Cleaners.

Infiltration tactics fail against two-way cleaning action of this Oil Bath Air Cleaner!

Dust is a sly and relentless enemy but it's fighting a losing battle here. A Cycoil Oil Bath Air Cleaner at the air intake of each of these 1350 H. P. compressors presents a solid defense against "sneak" or "all out" attack.

Cycoil's two-way cleaning action leaves no room for even a small percentage of dust to reach the engine. Thorough mixing of the intake air traps over 90% of the dust, right at the start. Final cleaning action of the filter pads "mops up" the remaining 10% of fine dust particles that slip by the best of front line defenses.

Your dust protection dollars represent only a small fraction of the investment which they guard. Any air cleaner delivering less than Cycoil's approximate 100% efficiency is only fighting a delaying action—a delay against eventual shutdown for costly repairs caused by dust damage. Write today for complete product information and performance data. Ask for Cycoil Bulletin No. 130.

AAF

American Air Filter

COMPANY, INC.

402 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

Here are a number of crankshafts of various sizes and types. They will be delivered ready for installation with National Forge's guarantee of satisfactory performance.

FINISH MACHINING IS A SPECIALTY AT NATIONAL FORGE

NATIONAL FORGE has excellent facilities for the finish machining of forgings. Our 1260-foot main aisle and the side bays house a multiplicity of precision tools.

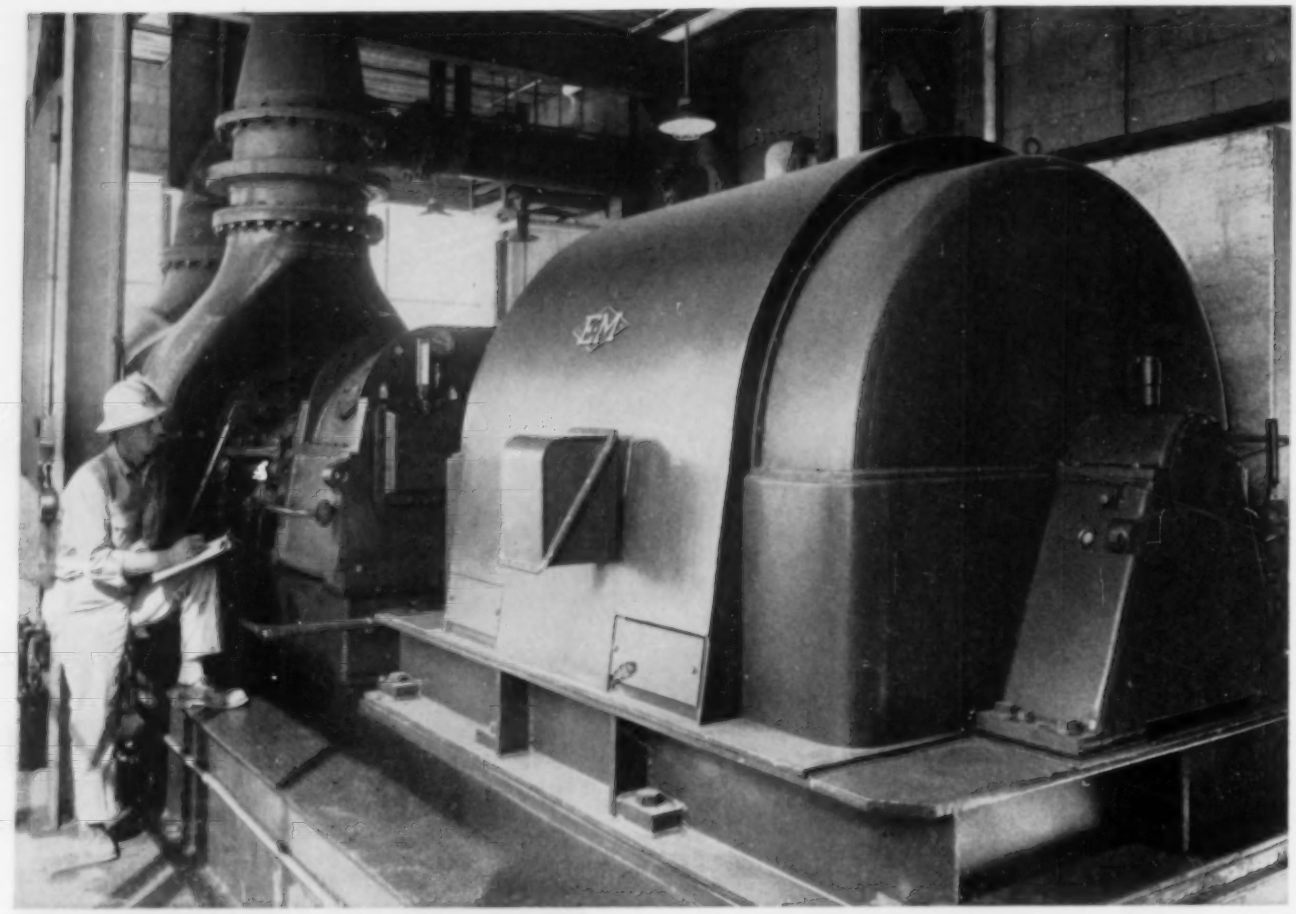
There is a full complement of lathes for both turning and boring in sizes from small bench lathes up to lathes of 72″ swing and beds up to 120′; boring mills, vertical and horizontal; planers; radial drills up to 6′; surface grinders for flat work; cylindrical grinders for work up to 26″ diameter and 50′ long; shapers—horizontal, vertical and traveling head; milling machines—vertical, horizontal and planer type; a jig borer; pin-turning lathes for crankshafts; slotters, up to 36″ stroke; and many other machines and tools designed for special work.

Our machinists are carefully trained over the years, and wherever your operation calls for special skill, these men are expertly adapted to your work.

When you have finish machining to be done on a forging, no matter how intricate or how close the tolerances, you can depend on National Forge to turn it out to your exact specifications.

We will be glad to quote on any job you have... and our Engineering Service is available to assist you if you desire.

National Forge
AND ORDNANCE COMPANY
Irvine, Warren County, Pennsylvania



Twin Cities' first refinery uses economical electric motor drive for turbo-blower

At St. Paul Park, Minnesota, a suburb of the Twin Cities of St. Paul and Minneapolis, Northwestern Refining Company is operating the area's first refinery. Originally designed for a capacity of 8,000 barrels a day, the plant capacity is being increased to reach a daily volume of 30,000 barrels.

Located in practical proximity to both Canadian Alberta and Williston Basin Oil Fields, the Northwestern plant is the last word in modern design and operation techniques. The regenerator of the catalytic cracking unit gets its air from a large turbo-blower driven by a compact, efficient E-M Squirrel-Cage Induction Motor . . . 3000 hp, 1780 rpm, 4160 volt, pedestal-type.

This E-M Motor provides three-fold economy on this installation:

1. Electric motor drive has low first cost.
2. No expansion of steam generating facilities necessary.
3. In this installation, electric power costs are lower than the costs of operating a steam plant of equivalent output.

Special features of this dependable E-M Induction Motor include: vacuum pressure impregnated coil insulation, with high dielectric strength . . . minimum vibration at high speed, through precision rotor balancing . . . across-the-line starting without a large voltage drop, through special E-M design of winding, slots, length of magnetic core, and other factors.

These E-M Motors also provide economical drives for large centrifugal pumps in pipe line pumping stations, eliminating costly, bulky equipment required to generate other forms of drive power. Other applications show similar dependability and economy.

Your nearest E-M sales engineer will be glad to fill in facts and figures on this hard working E-M Motor for you. And write the factory for *Publication No. 214* on *large* E-M 2-pole and 4-pole induction motors.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

1300-TPA-2141

E-M

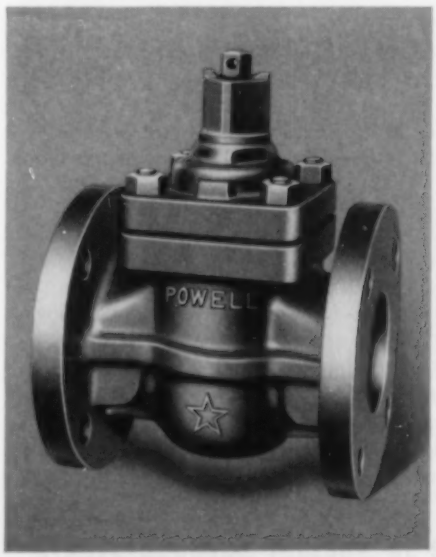
Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

The Finishing Touch

Small details can make a big difference in trimming a tree . . . and in manufacturing valves. For example, *every* Powell Valve part must pass *rigid inspection*. Then, as a final, finishing touch, each Powell Valve is subjected to *actual line tests*.

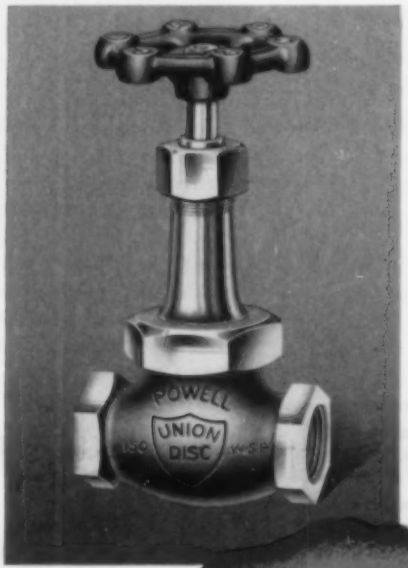
It's these seemingly small details that have helped Powell Valves maintain their record of dependability since 1846. Powell has probably done more valve research, solved more valve problems, and makes more types of valves than any other organization in the world.

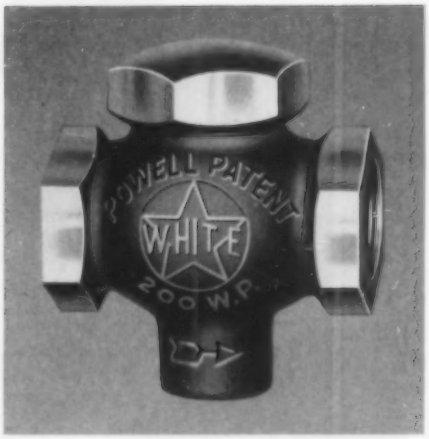
With Powell Valves on the job in your plant, you'll say every day's a holiday from flow control worries. Following are just a few of the valves that have the gift of dependable service you want—and need. They're available through distributors in principal cities. If a distributor is not located near you, just write us. We'll be pleased to tell you more about these valves—and our complete line.



LUBRICATED PLUG VALVE *(Fig. 2201)*, flanged end. Available with screwed or bolted glands. Semi-steel valves available for 175 and 200 pounds W.O.G. Carbon Steel Valves available for 150 and 300 pounds W.P.

BRONZE GLOBE VALVE *(Fig. 150)* for 150 pounds W.S.P. at 500 F. Screwed ends, union bonnet, renewable vulcanized composition disc. Sizes ⅛" to 3", inclusive.



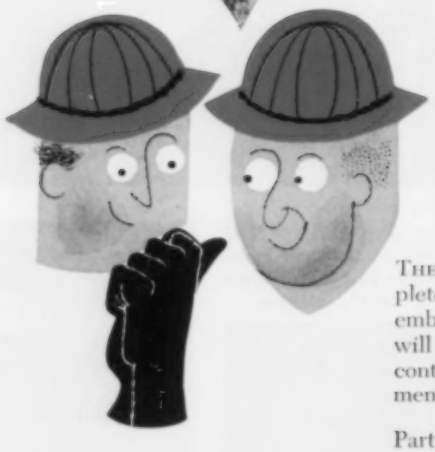


BRONZE "WHITE STAR" DASH-POT CHECK VALVE *(Fig. 95)* for 200 pounds A.W.P. Designed for air compressor service. Screwed ends, screwed cap, regrindable, renewable, wear-resisting bronze disc. Cushioning of plunger in dash-pot makes seating of disc practically noiseless. Sizes ⅛" to 3", inclusive.

DEPENDABLE VALVES SINCE 1846

Powell Valves

THE WM. POWELL COMPANY • CINCINNATI 22, OHIO

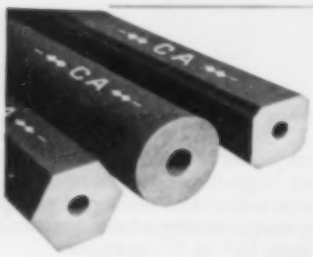


they're using CRUCIBLE HOLLOW DRILL RODS at FOLSOM DAM

THE FOLSOM DAM project is a big construction job. When completed it will be 340 feet high, 1400 feet long—with wing embankments extending for more than two miles. The new dam will provide a source for irrigation and power, and serve to control flood conditions in the American River Basin near Sacramento, California.

Part of the construction work involves the excavation of more than 9 million cubic yards of earth and rock. Here's where Crucible Hollow Drill Rods are playing a mighty important role. They can't be beat when it comes to hard rock drilling operations.

Crucible Hollow Drill Rods are made to tool steel standards by the world's largest producer of tool and other special purpose steels. This *extra* quality assures you of minimum rod breakage . . . and fewer valuable bit losses. For dependability in rock drilling, buy Crucible Hollow Drill Rods.



CRUCIBLE first name in special purpose steels

53 years of *Fine* steelmaking

HOLLOW DRILL ROD

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

BUCYRUS-ERIE Announces the 180-W

■ ■ ■ A NEW 5 CU. YD. WALKING DRAGLINE

Combining Big Output Capacity And Long Working Reach With Unusual Portability

Diesel or Ward Leonard Electric

THIS NEW Model 180-W offers the operating features that have proved so successful in many years of actual field performance by the outstanding line of Bucyrus-Erie walking draglines. In addition, it offers exceptional shipping and erecting ease for a machine so large — only partial disassembly necessary for moving from one stripping job to another. This means substantial savings in moving time and expense, as well as increased machine value throughout its entire life.

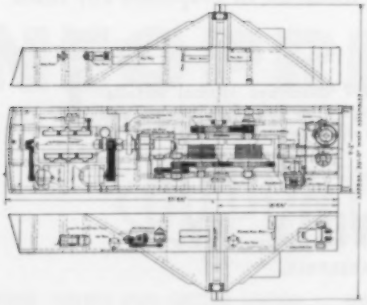
- Big output capacity from fast cycle, quick moves, steady all-weather performance.
- Long reach where needed — with 5-yd. bucket the 180-W will move material 244 ft. in a 180 degree swing.
- Knocks down into large sections for easy moving and erecting.
- Easily maneuvered to most effective working position with Bucyrus-Erie's exclusive walking mechanism.
- Large bearing area permits working on soft ground.
- Low maintenance with a minimum of moving parts.
- Simple main machinery.
- All-welded boom with tubular braces for light weight, plenty of strength.

Send for complete information on the 180-W
5-yd. bucket with 120 ft. boom
4-yd. bucket with 135 ft. boom

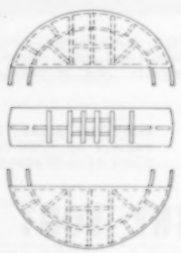
39L53

BUCYRUS ERIE

BUCYRUS-ERIE COMPANY
SOUTH MILWAUKEE, WISCONSIN



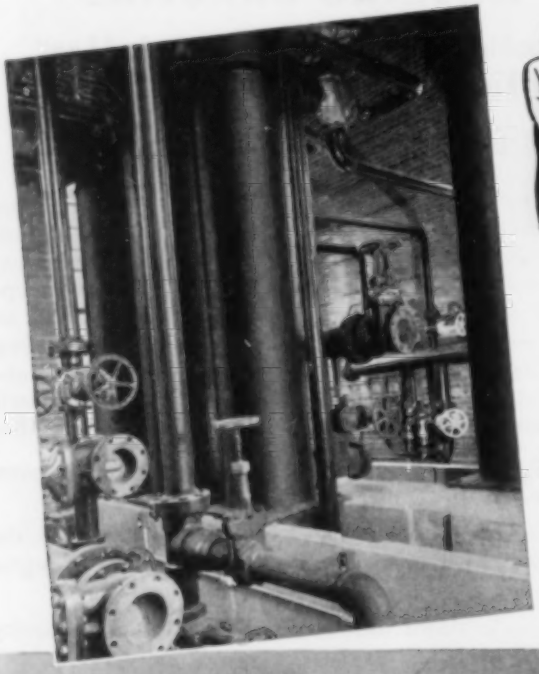
For shipment the side wings unbolt from center section of revolving frame. The main machinery remains fully assembled and in proper alignment. The entire machine is easily loaded on five U.S. railroad cars.



The base is made up of three separate welded-steel sections which are joined in the field by bolting flanges. It is easily disassembled and shipped.

Dirty Water can't "Shut-down"...

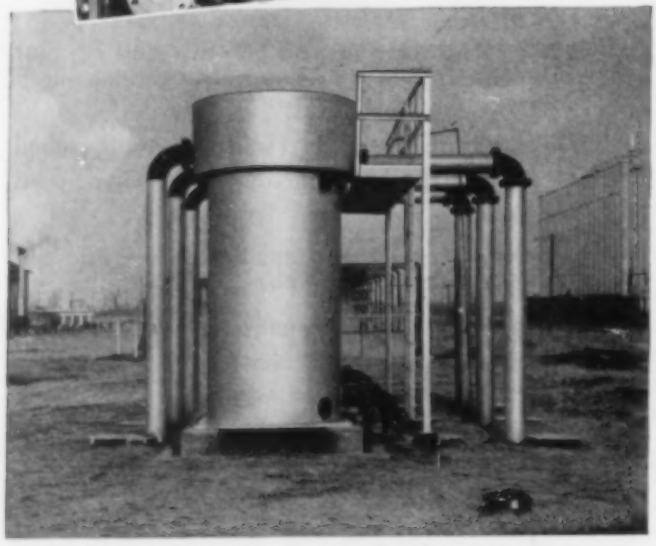
Vogt



film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

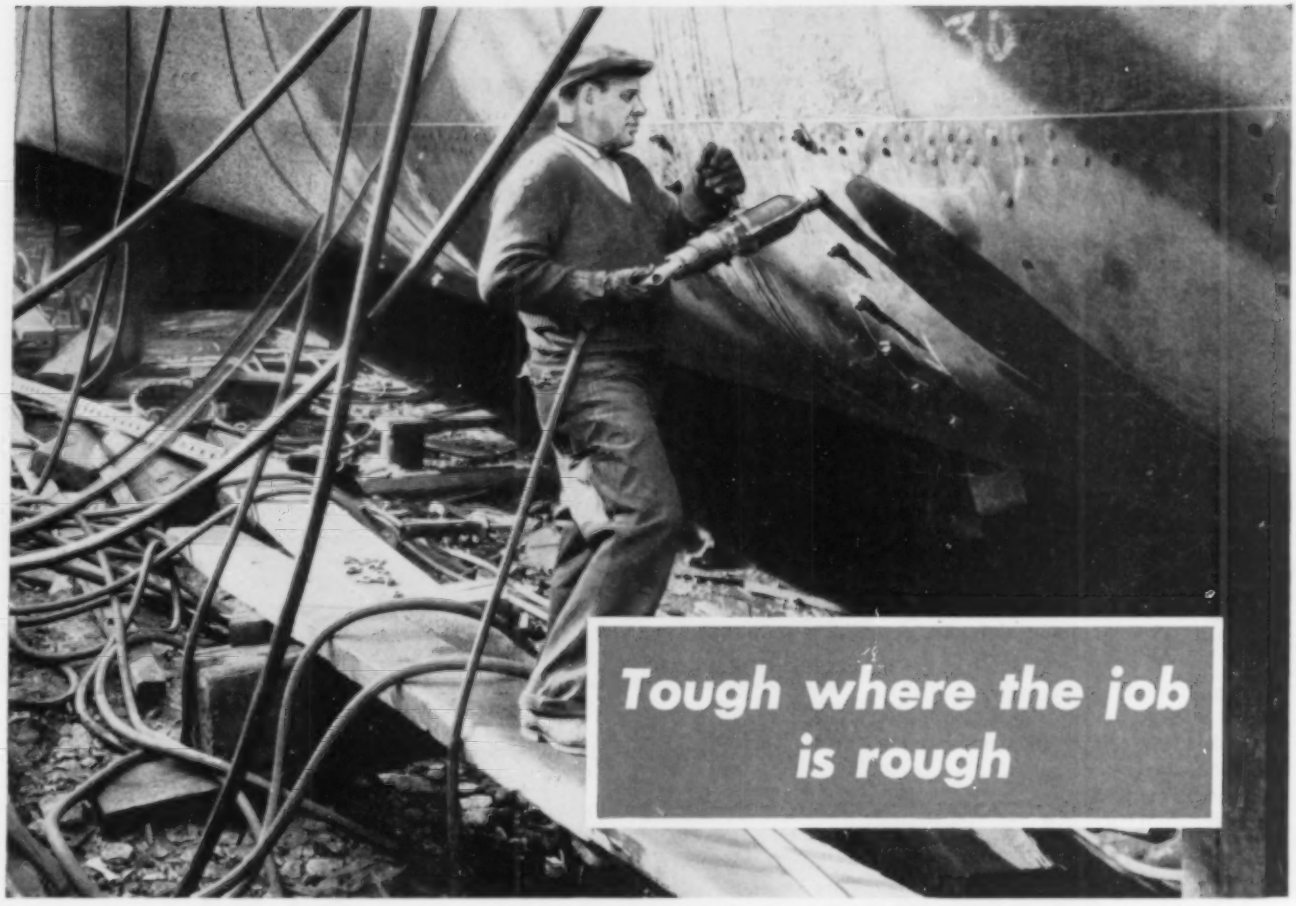
TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



Air hose with cover and tube of NEOPRENE gives dependable service in ship construction

It takes a rugged man to handle an impact wrench in a shipyard—and a rugged hose to supply compressed air for the job. The hose here is subjected to constant flexing and the roughest kind of abrasive conditions (as pictured above). It is dragged over sharp metal edges, pulled around corners, and scuffed and scraped by obstructions of all kinds . . . while inside the tube is hot, oil-laden air. Yet here's an air hose that can take the most punishing treatment. It's made inside and out with neoprene.

THE COVER OF NEOPRENE is tough and durable . . . resists abrasion, cutting and chipping throughout its long life. And, because neoprene can withstand the deteriorating effects of sunlight, heat and weathering, the fabric reinforcement receives maximum protection.

THE NEOPRENE TUBE won't go to pieces when exposed to hot lubricating oil in the air stream. No crumbled particles are carried along to clog vital tool parts. And neoprene's toughness and flexibility assure long, trouble-free service under the most adverse conditions.

DU PONT SUPPLIES neoprene to air hose manufacturers who use it in their top-quality lines. Ask your supplier about hose with cover and tube of neoprene. He'll be glad to show you how it's built for rugged service.

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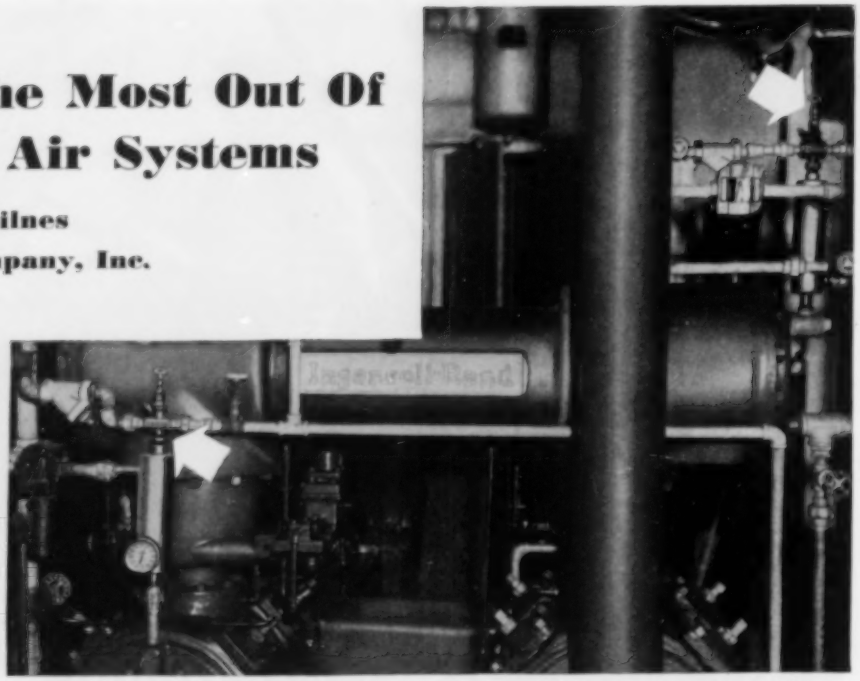
How To Get The Most Out Of Compressed Air Systems

A. Milnes

Sarco Company, Inc.



The replacement of hand controls by Sarco automatic cooling controls on this 2-stage Ingersoll-Rand compressor resulted in better lubrication, less condensate in air, and a considerable saving in cooling water.

THE practical place to measure the capacity of your compressed air system is where it counts the most—at your compressed air tools. From the time air is first drawn into the cylinder, many things can happen which will effectively reduce air pressure and limit compressor capacity. Following is a concise explanation of the major causes of reduced compressor capacity and the steps which can be taken to remedy them.

PROPER AIR INTAKE

Your compressor system can be fouled up before a pound of air has been compressed if the air intake has been improperly located. The air intake should be located where the atmosphere is clean, cool, free from corrosive chemical fumes, and dry to minimize condensation in the system.

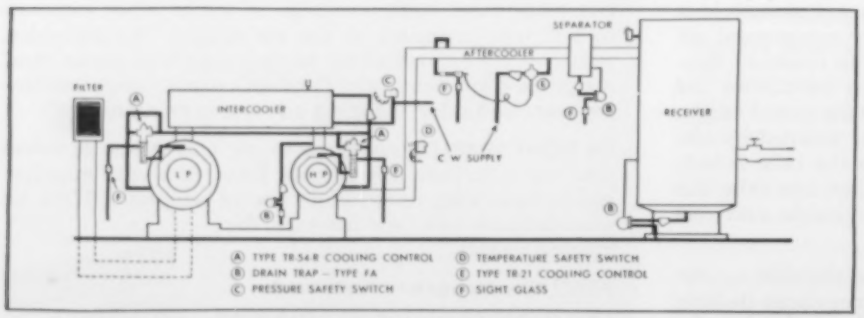
INTAKE PIPE DESIGN

A compressor can only operate at rated capacity if its air supply is unimpeded. Twisting, undersized pipes and dirty filters can effectively reduce air pressure at the compressor inlet. For example, a pressure loss of 2 psi due to friction in the intake pipe and filter will reduce the output of a 125 psi compressor by 7.5%. Check intake pipes and make sure they are short, of adequate size, and free of sharp bends.

AUTOMATIC COOLING CONTROL

One of the major causes of inefficient compressed air operation is unbalanced cooling. For example, overcooling wastes water, causes deterioration of compressor lubricant by condensation in cylinder head. On the other hand, undercooling reduces compressor capacity, may result in serious damage to cylinders, pistons, valves and seats.

To offset this, many compressor manufacturers such as Schramm, Ingersoll-Rand, and others install Sarco automatic cooling controls at the factory. These controls are self-modulating, insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply.

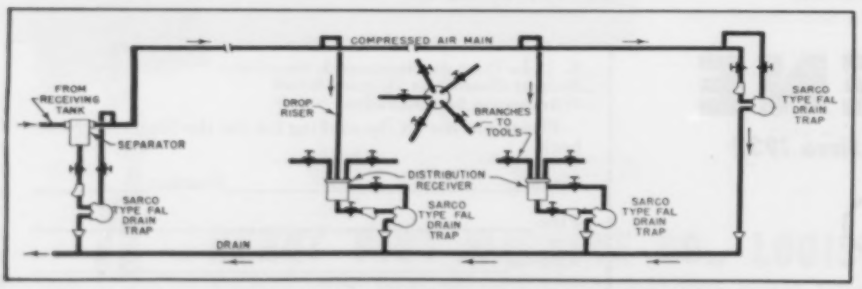


Sarco cooling controls are installed to regulate the water supply to cylinder jackets so that jacket discharge temperature is between 100-115° F.

CONDENSATE REMOVAL

If condensation is not kept to a minimum serious damage can result to tools, paint surfaces, molds, etc. Other results of excessive condensation in the system are water hammer and freezing of mains, receivers and tool exhausts.

To prevent this, well-designed compressed air systems usually have Sarco drain traps installed at the aftercooler, on separators, at receivers, and on low points in the lines to remove water as quickly as it collects.



Drain traps at critical points in the distribution system effectively remove condensate — protect compressor equipment, tools, and work.

FREE TECHNICAL ADVICE

Sarco engineers have prepared a technical bulletin designed to pass on to compressed air users practical advice on how to improve air compressor operation. It also contains simple hook-ups of Sarco cooling controls and drain traps.

This bulletin may be obtained without obligation by writing the Sarco Company, Inc., Empire State Building, N.Y. 1, N.Y. Also represented in principal cities.

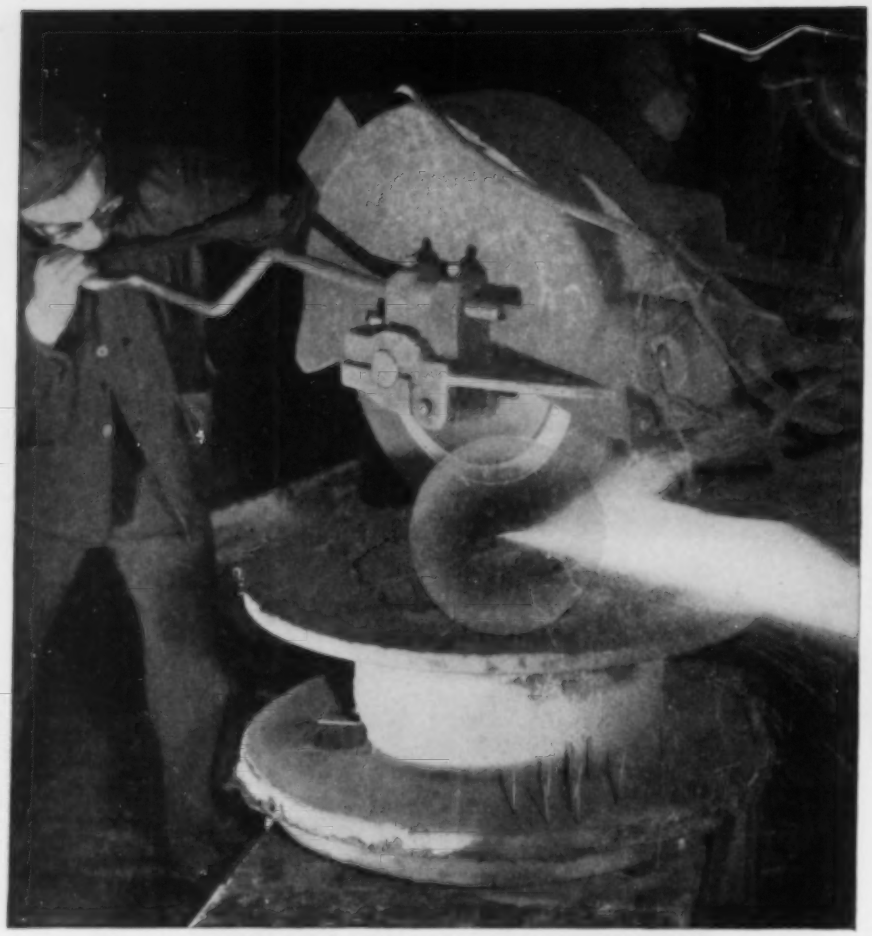
Wire Rope at Work — This is the woodyard at Kraft Center, Cantonment, Fla., one of the largest enterprises of the St. Regis Paper Company. Here they build and move mountains — enormous mountains of logs. The stockpiles normally carry an inventory of 30,000 cords, and 1200 to 1400 cords are fed daily to the chippers at the paper mill.

The cranes you see in the yard are moving vast quantities of pulpwood, building up reserves so that the mill, with its healthy appetite for logs, will never go hungry. This is a job, too, for Bethlehem Wire Rope, which is rigged on the hard-working cranes. It is a punishing chore by any standard, the kind entrusted to Bethlehem rope in virtually every type of industry, wherever there's lifting or hauling to be done.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

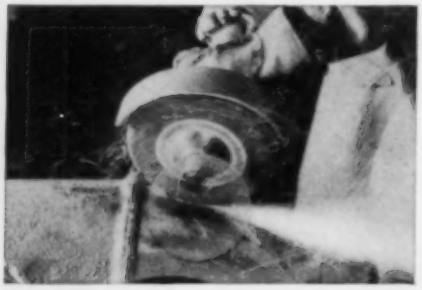
Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

MINING • CONSTRUCTION • PETROLEUM • EXCAVATING • QUARRYING • LOGGING • MANUFACTURING



On swing frame grinders Norton wheels stand up under heavy grinding pressures at high speeds, combining fast, clean cutting action with extra long wheel life. For high tensile strength metals use ALUNDUM* abrasive; for low tensile metals, CRYSTOLON* abrasive.

On floor stands you grind faster and at lower cost with Norton ALUNDUM or CRYSTOLON wheels. There's a right Norton abrasive-and-bond combination for every metal, every job.



On portable grinders the smaller Norton wheels do the same big job of cost cutting. With their inbuilt balance they *hug that work* — to grind more metal per man-hour.

On many jobs the versatile Norton Nylon-Reinforced Hub Wheels — BD rigid and BFR semi-flexible — are the fastest, easiest, *safest* wheels to use. They're ideal for weld grinding and similar finishing operations.

Bring out the hidden profits in your rough grinding with the

"TOUCH OF GOLD"

Rough grinding jobs *can* be as definite money-making operations as any other form of grinding.

And they *will* be when you add the "Touch of Gold" with Norton wheels that are exactly right for the work you're doing on the machines you're using.

Then you'll grind off more metal per dollar, increase production and cut costs every day, on countless routine jobs.

And you'll realize that the *hidden profits* in your rough grinding operations need only this time-and-money-saving "Touch of Gold" to bring them to light.

Your Norton Distributor

can bring long, practical experience to your rough grinding problems. If necessary, he'll call in your Norton Abrasive Engineer for expert advice on new or difficult applications. Backed by the world's largest manufacturers of abrasives, with the broadest line to choose from, these Norton men will make sure you get exactly the wheels you need.

Ask your Norton Distributor for Booklet No. 1405 . . . 54 illustrated pages covering every phase of rough grinding. Or write direct to NORTON COMPANY, Worcester 6, Mass. Distributors in all principal cities — look under "Grinding Wheels" in the yellow pages of your telephone directory. *Export:* Norton Behr-Manning Overseas Incorporated, Worcester 6, Mass.

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ON THE COVER

THE picture shows water flowing for the first time into the Los Angeles Department of Water & Power's $1,381,000 Eagle Rock Reservoir. The basin is supplied with water through a connection with the Metropolitan Aqueduct distribution system. The delivery line from Eagle Rock Reservoir to Hollywood Reservoir has a daily capacity of 171 million gallons and reflects the growing importance to Los Angeles of Colorado River water.

KEEPING CHRISTMAS

"It is a good thing to observe Christmas Day. The mere marking of times and seasons, when men agree to stop work and make merry together, is a wise and wholesome custom. But there is a better thing than the observance of Christmas Day, and that is, keeping Christmas.

"Are you willing to forget what you have done for other people, and to remember what other people have done for you; your rights in the background, and your duties in the middle distance, and your chances to do a little more than your duty in the foreground; to own that probably the only good reason for your existence is not what you are going to get out of life, but what you are going to give to life—are you willing to do these things even for a day? Then you can keep Christmas.

"Are you willing to stoop down and consider the needs and the desires of little children; to remember the weakness and loneliness of people who are growing old; to try to understand what those who live in the same house with you really want, without waiting for them to tell you; to trim your lamp so that it will give more light and less smoke, and to carry it in front so that your shadow will fall behind you—are you willing to do these things even for a day? Then you can keep Christmas.

"And if you keep it for a day, why not always?" —*Henry Van Dyck*

Compressed Air Magazine

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VOLUME 58 **December, 1953** NUMBER 12

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A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit

Published by Compressed Air Magazine Co., G. W. MORRISON, *President;* C. H. VIVIAN, *Vice-President;* A. W. LOOMIS, *Vice-President;* J. W. YOUNG, *Secretary-Treasurer.*
Editorial, advertising, and publication offices, Phillipsburg, N. J.
New York City Office, 11 Broadway. L. H. GEYER, *Representative.*
Annual subscription: U.S., $3.00, foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index and in Engineering Index.

LPG TERMINAL

These pictures and most of those that follow show the facilities at Warren Petroleum Company's LPG terminal in Des Moines, Iowa, which are operated by Rapid-Thermogas Company. The thirty-two 30,000-gallon storage tanks are divided into three banks by a fire wall that was built by shooting concrete against steel reinforcing with compressed air. Risers extending upward from the safety valves are insurance that if any of the heavier-than-air gas should blow off it will be carried high enough for wind currents to disperse it harmlessly. Details of the end of one of the tanks are shown at the right. A pressure gauge is at the top, a thermometer at the bottom and an ingenious liquid-level indicator in the center. A small valve on the outside of the tank is connected to a small pipe on the inside that is movable through a 360° arc in a radius corresponding to that of the tank. To measure the liquid level, the valve is opened and the pipe turned until the vapor discharging from the valve is replaced by liquid. The valve is then closed and an indicator gives a direct reading of the percentage of the tank's capacity that is occupied.

Bottled Power

THE STORY OF LP GAS

Robert J. Nemmers

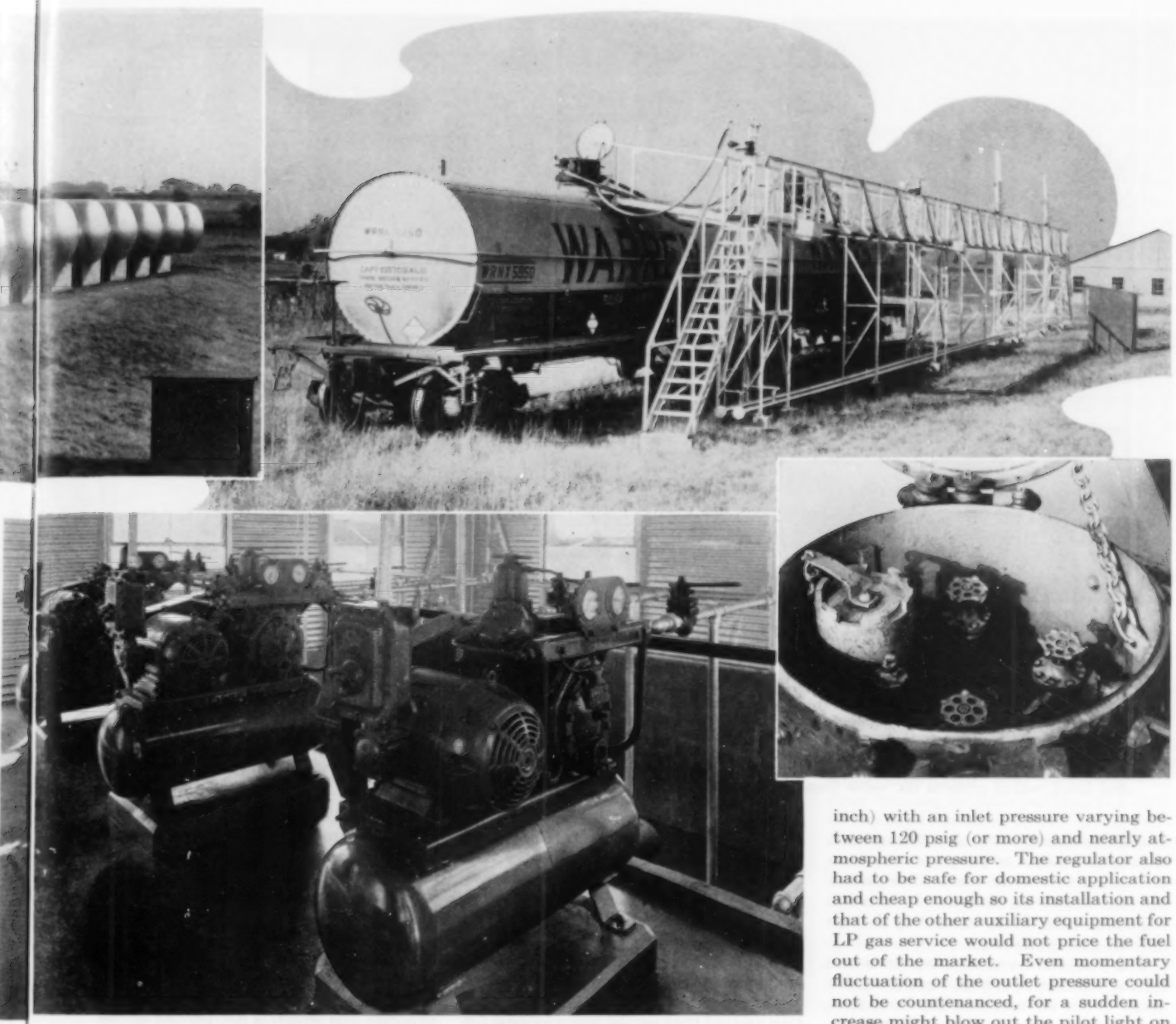
MARKETED production of a natural resource that was once thrown away reached an all-time high of nearly 4½ billion gallons in 1952. The product, liquefied petroleum gas, generally termed LP gas, was formerly allowed to boil away uselessly from oil wells or was wasted when collected as a liquid deposit from high-pressure natural-gas pipe lines. Today it is burned in cook stoves and to heat farmhouses far from city utility mains, to fuel farm tractors, and in some cases it is even used by modern agriculturists to operate air-conditioning units and refrigerators.

LP gas serves many industries and municipal gas utilities as a standby supply, and in certain areas it is mixed with manufactured gas to increase its Btu or heating value. Some owners of fleets of motor transports not only drive large trucks and buses with it but also smaller delivery wagons, and do so at a cost anywhere from 5 to 35 percent below that when operating them with gasoline. Its components are vital to the making of synthetic rubber, and the fuel is burned in driers in tobacco curing sheds and used to cut and trim steel as well as to eradicate weeds.

The forerunner of LP gas was introduced half a century ago in Augsburg, Germany, by Herman Blau, a young chemist who named his product Blaugas. Synthetically compounded of permanent gases and light fractions of gasoline, it was compressed into small steel bottles for distribution and used for lighting streets and homes. Although expensive, it achieved modest popularity in Europe and, later, among Americans who could afford it. In the United States it was dubbed "bottle gas," the name under which LP gas is still known in many parts of the country.

LP gas was "discovered" sometime prior to 1912 when it was noted that the liquid condensing out of natural gas in pipe lines contained flammable substances, gaseous at normal temperatures and pressures, that might have commercial value. The condensate was termed "drip gasoline," and in that year methods were worked out for storing the product in liquid form in steel tanks and using it to heat and light farm homes. The gas was likewise applied successfully to cutting billets and removing risers from steel and gray-iron castings.

A product similar to drip gasoline was also extracted from natural gasoline by condensing the vapors rising from storage tanks. However, the pressure required to liquefy this mixture of propane, ethane and butane was so great



UNLOADING RACK AND COMPRESSORS

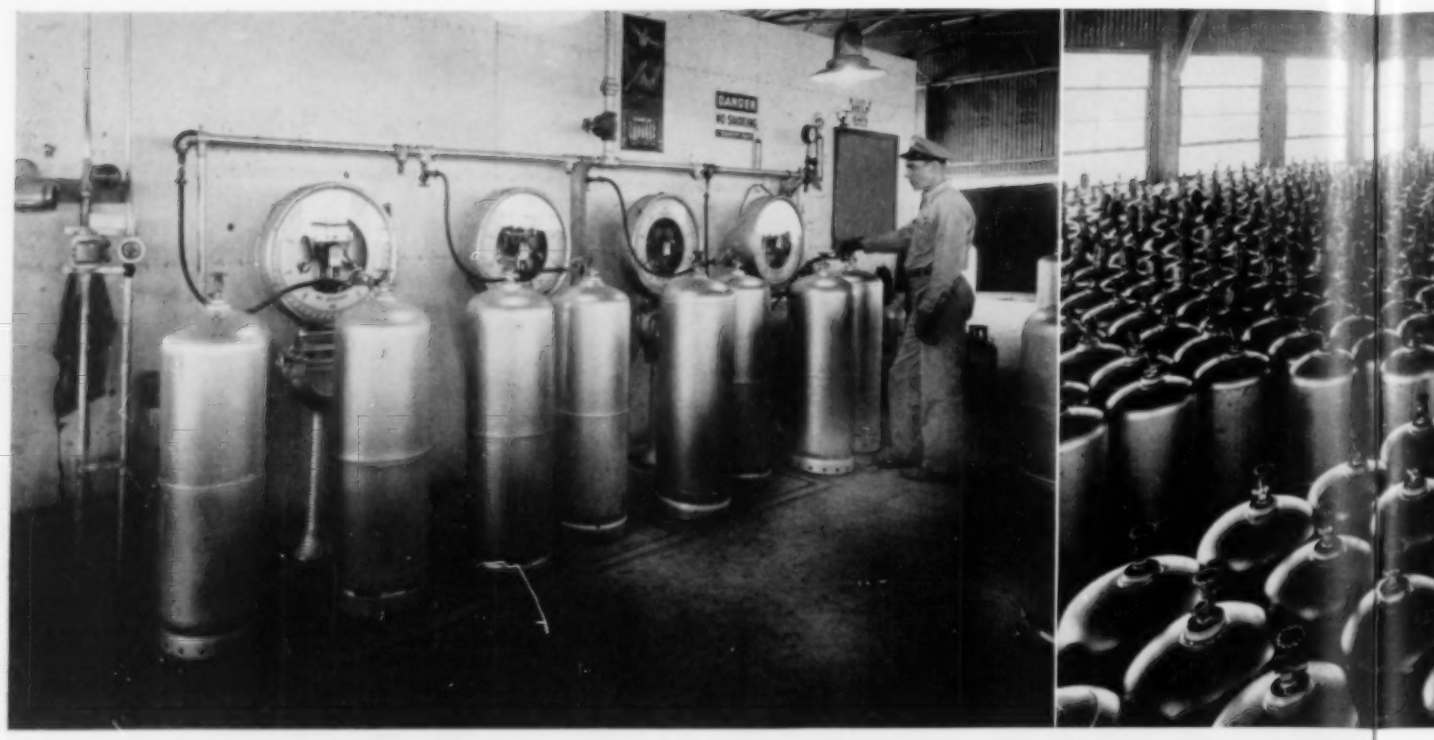
Flexible connections make it possible to unload four cars simultaneously. Cars and rack are electrically grounded to prevent static discharges. A close view of the tank-car valving system, lower right, shows two liquid valves (upper and lower center) to speed unloading and a vapor connection on the right. Transfer from cars to storage tanks is accomplished with the aid of the three Ingersoll-Rand air-cooled compressors that are pictured above. They are driven by Louis Allis explosion-proof motors. The vessel mounted between the compressor cylinders serves as a means of adding oil to the crankcase without releasing the gas present there at storage-tank pressure.

that heavy steel cylinders were needed to hold it. Later, fractionating methods were devised to remove the ethane, leaving varying ratios of propane and butane, the next form of LP gas. The withdrawal of ethane correspondingly lowered the pressure necessary for liquefaction, but even so the cylinders were still too heavy—it took 3 pounds of steel to confine one pound of LP gas. Today, the two gases are frequently separated and marketed individually. Likewise, refinements through the years have reduced the weight ratio of container to gas to 0.7 pound of steel to one pound of gas.

One of the early problems facing the industry was the design and production of a regulator for the gas that would be efficient, easy to maintain and economical. That was no small order, for the device had to supply gas in volumes ranging from 0 to 10 or more cubic feet per minute and, at the same time, maintain a constant outlet pressure of 11 inches water gauge (about 6 ounces per square inch) with an inlet pressure varying between 120 psig (or more) and nearly atmospheric pressure. The regulator also had to be safe for domestic application and cheap enough so its installation and that of the other auxiliary equipment for LP gas service would not price the fuel out of the market. Even momentary fluctuation of the outlet pressure could not be countenanced, for a sudden increase might blow out the pilot light on Mrs. Jones's stove, causing leakage and, possibly, an explosion.

Another of the industry's early problems was the finding of suitable diaphragms and packing for control valves and regulators. Grease-impregnated and rubber packing satisfactory for use with natural gas dissolved quickly when brought in contact with propane. The trouble persisted until composition packing was made. Difficulty was likewise experienced with the rubber hose then available, for the highly volatile gas soon destroyed it. It was not until synthetic rubber was developed that the problem was solved.

The physical properties of propane and butane (they are colorless and odorless) made it necessary for marketers to add, as do natural-gas distributors, an odorizing agent that would warn people of leaks or open unlighted burners. One of these is ethyl mercaptan, which



BOTTLED PROPANE

On the charging ramp, above, each cylinder is filled with 100 pounds of liquid propane. The average fully charged bottle has a gross weight of about 174 pounds. Some 250 cylinders per hour can be charged by one attendant, who moves back and forth along the line. The storage area is large enough to hold thousands of bottles, but still can't begin to accommodate all the company owns. For each twin-cylinder installation (one on a midwest farm is shown at the extreme right) there must be at least four bottles—two in service and two at the loading depot, on a truck or in dealer storage. Before they are sent out, each receives a heavy steel hood, which protects the valve from accidental opening or damage.

smells like skunk or rotten cabbage and is generally added to LP gas at the time of loading into tank cars. One pound per 10,000 gallons suffices. It loses its sickening odor when burned in LP or natural-gas appliances.

The year 1928 was an auspicious one for the industry, perhaps luckily so, for many of the advances made about that time helped to tide the still wobbly business over the depression years. It was then that composition packing for LP gas-system valves and regulators appeared and lower liquefaction pressures enabled a changeover from 2- to single-stage regulation, a development that lowered the cost of domestic installations and their maintenance.

The use of LP gases in public-utility stations also dates back to 1928, when the Phillips Petroleum Company installed LP gas enrichment facilities in a manufacturing plant at Davenport, Iowa. Other "firsts" in that year included a set of standards for the industry released by Underwriters' Laboratories, gauges manufactured specifically for the industry, and LP gas refrigerators designed by Servel, Inc. The latter organization now makes both refrigerators and year-round combination heating and air-conditioning systems of that type.

By 1930, according to a Bureau of Mines report, the LP gas industry had reached into all the 48 states and was rapidly gaining in popularity in other countries. The first motor-transport trailer for liquid-petroleum gas also came along about that time and made it possible to supply many small towns not served by rail facilities. Another innovation around that period was a system for distributing the gas throughout an entire community. One was laid in Belvidere, N. J., by Mark Anton who, two years later, became the first president of The National Bottled Gas Association, an organization that was formed to foster the growth of the industry, to set up ethical trade practices and to promote the standardization of equipment. Production that year jumped to more than 33 million gallons

At the time the association was started, the status of the LP gas business was one of "boom or bust" largely because of seasonal variations in the amount consumed. Research departments turned to the internal-combustion engine as a potential user of the fuel and one, it was hoped, that would serve to even out the peaks and valleys. It was discovered that an experimental auto powered by LP gas had been operating on the streets of New York City as far back as 1912 and that the average cost of the fuel was in most cases 5 to 35 percent cheaper than gasoline, making it feasible for owners of fleets of large trucks and buses to use the gas.

Laboratory work since that time has revealed five major differences between gasoline and LP gas engines, all of which can be easily overcome by converting from the former to the latter type. This necessitates, first, substituting a pressure tank for the normal gas tank and, second, a regulator for the conventional fuel pump; third, providing a carbureting system that will handle an air-gas mixture instead of an air-liquid mixture; fourth, eliminating the "hot-spot" manifold which causes the liquid gasoline to vaporize and which is not needed or desirable in a gas engine; and, finally, an increase in the compression ratio (the degree of compression of the gas-air mixture before firing takes place). This is accomplished by "shaving the head" and reducing the clearance space in the combustion chamber, just as is done by "hot-rod" enthusiasts. The higher compression ratio may be used because of the difference in octane rating between LP gas (propane 125) and gasoline (premium grade approximately 90). Generally, this ratio is increased from the usual 6.3 to 1 to 7.5 or 7.8 to 1 where butane-propane mixtures are burned; but where commercially pure propane is available it may be stepped up to 10 to 1 for better engine performance.

Cost of conversion runs about $225, depending on the size of the fuel tank and the type of vehicle. Because of this additional outlay it is improbable that many private automobiles will ever be

converted to LP gas, for most of them do not cover enough mileage in a year, comparatively speaking, to make it economical. Besides, present gasoline filling stations are not equipped to dispense LP gas, and those that are usually do not offer the varied services motorists have come to expect. For trucks or buses making runs between given points, however, LP gas has the initial advantage of being sufficiently cheaper than gasoline to pay for the changeover.

Certain other economies all having to do with the life of the engine and the lubricating oil also have become apparent. It is commonly said by petroleum companies that a good oil does not "wear out," it just becomes dirty and diluted by gasoline so that its lubricating quality is impaired. In an LP gas engine there is no liquid to wash down the cylinder walls into the crankcase. Therefore, if a vehicle so powered has a good oil filtering system, the time lapse between oil changes will be longer. Again, because of the gaseous nature of the fuel, complete mixing of the gas and air takes place, resulting in more even burning in the engine, less wear and corrosive action on valve facings and, consequently, an increase in the interval between overhauls and in the service life of the engine. Furthermore, because LP gas is completely combustible, it leaves no carbon deposits.

It is interesting to note that companies in the business of bottling liquefied petroleum gas are among their own best customers for the fuel so far as its use in motor vehicles is concerned, for the far-flung operations of some of them require their trucks to cover many thousands of miles a year in just going from place to place replacing empty bottles with freshly charged ones. By 1952, the use of propane in internal-combustion engines had advanced to the point where International Harvester Company and Reo Motors, Inc., which had designed LP engines for installation in their trucks, began the mass-production of models equipped at the factory to burn that fuel.

In 1936, the Waukesha Motor Company made available an LP gas ice engine—an air-conditioning unit—for railroad passenger cars. It consists of a specially designed Waukesha engine driving an Ingersoll-Rand gas compressor through multiple V-belts and drawing fuel from a bank of standard steel cylinders mounted under the car and having a capacity of 100 pounds each. The refrigerant is du Pont Freon. One hundred pounds of propane is sufficient to last fifteen hours at full capacity and, when consumed by the engine, has a cooling effect equivalent to 10,000 pounds of ice. (The corresponding electrical and mechanical equivalents of 100 pounds of propane are, respectively, 100 kw-hrs and 162 hp-hrs.) The bank is unloaded in sequence, and the cylinders may be replaced with freshly charged ones in a few moments and without interrupting operations.

Further efforts towards developing summertime uses of the fuel were carried on by the major oil companies with their large staffs of technically trained men, and it was not long before new products were on the market. Some of these such as chick brooders and small stoves for trailer homes account for only a slight increase in the aggregate demand, but another gas appliance is expected to go far towards smoothing out the uneven curve of the year-round sales. It is a tobacco-curing heater and has had a big effect on LP gas consumption in southern states. Curiously enough it was a small distributor who conceived this drier because he believed that it would be easier to maintain proper curing conditions with it than by the old method of hand stoking coke furnaces. Furthermore, because its cost and that of the fuel is low enough to enable the average tobacco grower of the South to own and operate units of this type, it was not long before this application caused an upswing in the LP gas economy in that section of the country.

Another development which has indirectly affected the peak-and-trough periods of LP gas consumption is the growing interest of industry in standby LP gas systems either to supplement their supplies of natural gas during periods of heavy demand or to take over their heating loads in areas where interruptible natural-gas rates are in effect, that is, where commercial users of natural gas may have their service curtailed or entirely cut off by a utility on days when domestic requirements are so high that it is hard pressed to meet them. The charges, as may be expected, are low in comparison with those prevailing in the case of a firm-rate structure under which the utility contracts to furnish all the gas a plant may need regardless of other demands. However, the burden of reserve facilities must be borne by industry itself.

Many concerns operating under the interruptible rate have found that, even

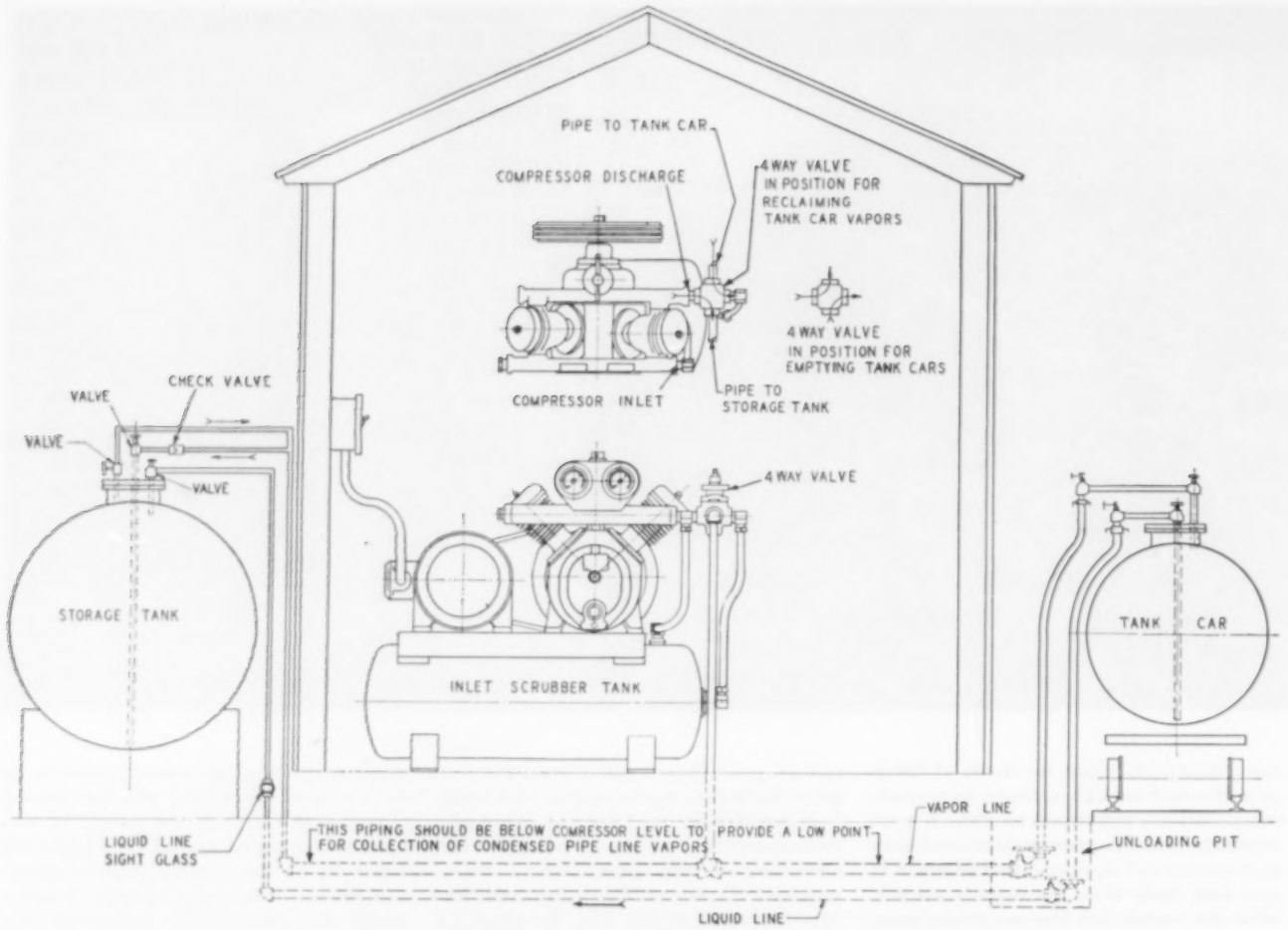


DIAGRAM OF UNLOADING EQUIPMENT

With the storage tank containing gas and the tank car liquid, valves are adjusted to draw out the gas, compress it and force it into the car, thus displacing the liquid and transferring it to the storage tank. Valves are then set to withdraw the gas from the car, compress it and pipe it into the storage tank under sufficient pressure for it to liquefy.

if the standby equipment is elaborate, their over-all heating bill is less than before its installation. This is so because they fill their own LP gas storage tanks during the summer months when they can buy the fuel at a reduced price and when they can get all the natural gas they need at the low interruptible rate. Frequently, the savings have been so appreciable that the cost of the standby plant was quickly amortized.

LP gas producers, like the natural-gas industry, have been examining varied types of storage facilities that can be filled in summer and drawn upon in winter so that they can operate at peak efficiency the year round. In some sections, large terminal tanks have been erected, while the attention of other LP gas-storage specialists have turned to the earth whence the gas came, believing it possible to store it in dry oil wells or wet salt domes (underground cavities) for withdrawal when needed. Progress in all these fields, plus increasing consumer acceptance, has made the industry a healthy and growing one.

Transportation of the fluid gas is no longer much of a problem. Most of it is shipped by rail to terminals where tank trucks complete the run. Past experience has proved that, provided certain precautions are taken, the fuel can be safely transported and handled. Different types of apparatus using, distributing and regulating the gas have been tested and approved by safety councilors and laboratories. Efforts are also being made to reduce the human element in unsafe practices to a minimum by carefully training the men who handle propane and butane and service the equipment. One such program will be dealt with later.

The greatest volume of LP gas is dispensed in the southwestern part of the country where it is produced and where freight rates do not raise the price. Running a close second is the Midwest where thousands of farms dot the countryside. Because of the long distances to be covered, this area has become the center of some of the largest LP gas operations in the country. The Midwest's biggest and oldest wholesale distributor of bottled gas is the Rapid-Thermogas Company with main offices in Des Moines, Iowa, and terminal and distribution facilities in twelve other cities in Iowa, Illinois and Wisconsin. To this network of plants will soon be added another now being erected in Waterloo, Iowa. Rapid-Thermogas markets only propane and receives its supply from Warren Petroleum Company of Tulsa, Okla., with which it shares terminal facilities in Des Moines.

The Des Moines installation may be taken as typical of the operations carried on by Rapid-Thermogas and others throughout the United States. The terminal, owned by Warren Petroleum Company, consists of thirty-two 30,000-gallon tanks which are brought up to capacity during the slack summer months and then drawn upon in winter to meet increased demands. The liquefied gas arrives by rail tank cars varying in capacity from 9500 to 10,500 gallons and is transferred to the storage tanks by a method which makes it possible to reclaim much of the gaseous propane in the tank cars. Three hoses are first attached to each car, the valving arrangement of which is shown in an accompanying illustration. Two of the lines are for liquid gas and the third for vapor.

As both car and storage tank are initially under approximately the same pressure (which varies with the temperature), transfer depends on establishing a pressure differential between the two by means of a compressor.

At the start of the operation, a 4-way valve is set so that the vapors are drawn from the storage tank into the tank car to force the liquid in the latter into the storage tank. When that has been done, the valve is adjusted and the vapors remaining in the car are compressed and returned to the storage tank. What this latter step means in dollars and cents is apparent when one examines the gallonage equivalents of the vapor in a car under, say, 197 psi pressure. In a 10,000-gallon car, for example, there will be 665 gallons of propane in the form of vapor. But if the pressure is reduced to 40 psi, there will be only about 156 gallons of the gas. Withdrawal below 15 psig is uneconomical because the pressure in the storage tank increases as the pressure in the tank car decreases and the amount of electric current required to effect the transfer goes up sharply to a point where it costs more to handle the gas than it is worth. A diagram of a typical transfer piping system is included among the illustrations.

The compressors (three of them) installed at the Des Moines terminal are specially constructed single-stage, 2 cylinder Ingersoll-Rand machines designated as Type 30 Model LPG. Each is driven by 5-hp explosion-proof Louis Allis motor and has a completely sealed crankcase which serves as an unloading chamber. Unloading is accomplished by means of a centrifugal unloader and pilot valve through relief lines from the cylinder to the crankcase. Other features that make it possible to use the type in this service are special LP gas gauges fitted with dampeners to offset the pulsating effect of both the inlet and discharge. Provision has also been made to prevent liquid that may condense in the inlet line from entering the compression cylinder. This is done by mounting the machine with its driver on a "scrubber" tank, running the vapor inlet line to the tank and taking the compressor inlet line from the top of the tank.

Before the gas is withdrawn from a tank car, a laboratory test is made of the amount of water present in the propane. If as much as a trace shows up, the fluid and vapor are passed through a pair of water and water-vapor removal towers. It is this moisture which, in many domestic installations, is the chief source of regulator maintenance trouble faced by distributors of LP gas mainly during cold weather. As the fuel issues from the regulator orifice, its rapid expansion causes a cooling effect. If the ambient temperature is also low, any moisture contained in the gas freezes and blocks the regulator, shutting off the flow. For this reason Rapid-Thermogas makes sure that no moisture gets into its gas or stays there if it does get in, thus cutting down the number of service calls its distributors must answer.

Rapid-Thermogas fills all its bottles used in and around Des Moines in a central plant where one man takes care of the entire operation, which is conducted on a weight basis. There are four scales, each of which is served by a fast-acting toggle valve on a flexible hose. The attendant sets the individual cylinders on the scales, attaches the loading lines by quick-connecting couplings, and then opens each valve, in turn, filling the flasks successively with 100 pounds of liquid gas. The tare weight of each cylinder (approximately 72 pounds) stamped into the metal near the top and an allowance of about 2 pounds for the hose, joint and toggle valve are subtracted from the scale reading to obtain the weight of the charge.

The operator keeps the bottles moving from each of the scales at the rate of about one a minute, filling around 250 an hour. The cylinders are delivered to him by way of a ramp directly from the paint room, where they are given a coat of heat-reflecting aluminum paint each time they are brought back for recharging. All the main storage tanks at the terminal, as well as most of the other fixtures, are similarly protected from the direct rays of the sun to prevent the absorption of too much heat. The charged flasks are then conveyed by means of a loading ramp either to delivery trucks for distribution in the immediate vicinity covered by the company or to larger trucks for delivery to its retailing dealers in the outlying area.

During the summer months, the gravity drop from the storage tanks is adequate to move the LP gas to the loading rack through underground pipes. In the coldest days of winter, however, when the pressure in the outdoor tanks falls by reason of lower temperature and increased rate of withdrawal, a boost is given the fluid by a small liquid pump.

In the main office building located at the terminal, Rapid-Thermogas has turned a large room over to two men

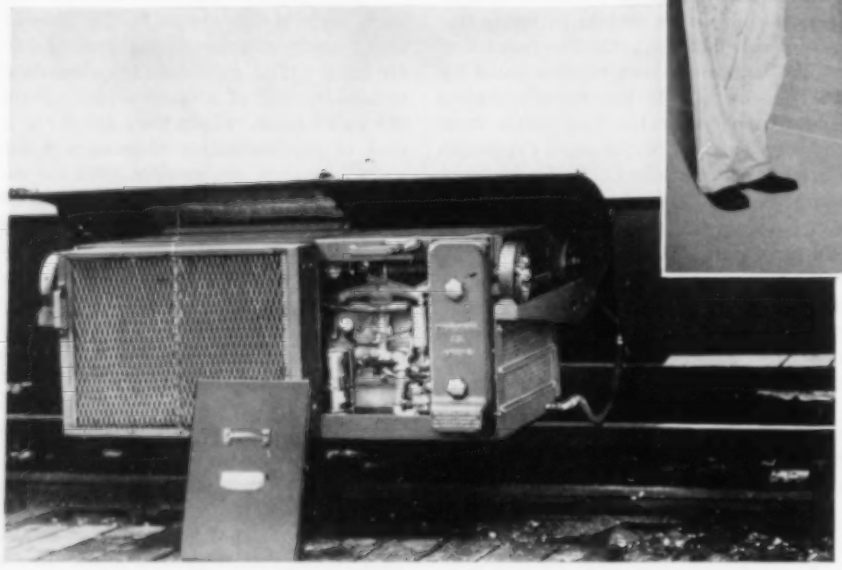
PROPANE STANDBY PLANT

An auxiliary supply of fuel for an industrial concern installed by the Peacock Corporation, specialist in this field. The small concrete-block structure in the foreground contains an Ingersoll-Rand LPG unloading compressor. The standard-size storage tank, 9 feet in outside diameter and 67 feet long, holds the equivalent, in heating value, of 2,400,000 cubic feet of 1000-Btu natural gas.

PHOTO, PEACOCK CORPORATION

COOLING AND HEATING

Below is a Waukesha ice engine that provides refrigeration for cooling the railroad passenger car under which it is mounted in such a way that it can be easily withdrawn for inspection and servicing. The engine operates with propane and drives an Ingersoll-Rand compressor. The refrigerant is Freon. The unit is thermostatically controlled from within the car. With 100 pounds of LP gas, it can produce as much cooling effect as 10,000 pounds of ice. The other picture shows an Elston LP gas heater designed for use in the cargo space of motor trucks or semitrailers. When in service, the gas chamber is ventilated from the outside and sealed off from the cargo area. Propane bottles are also changed from the outside. The 20-pound size contains enough fuel for 58 hours of operation in the coldest weather when thermostatic controls are employed.



whose task it is to train all their dealers and distributors and many of the latter's maintenance and service men in the art of handling the gas safely and quickly. The course includes proper installation practices and trouble-shooting techniques and runs a full week, with each day devoted to a different problem or type of appliance. When not so engaged at the terminal, the instructors travel around to the distributors' showrooms and plants and give individual aid, all in the interest of getting more customers for the bottled power and keeping old ones.

At the training center are sets of appliances with appurtenant regulatory devices. These appliances are maladjusted by the instructors, and the students are required to find and remedy the defects. Cutaway sections of many manufacturers' products show the workings, and manometers impress upon the trainees the necessity of using lines of proper diameter by indicating the pressure drop in different-size pipe and fittings.

The company also operates a testing station for the various types of appliances which use LP gas, and markets only those that are found to be dependable and economical in service. These tests range from determining whether or not an oven has "hot spots" that will cause a housewife's cookies on the top shelf to burn while those on the bottom are underdone to establishing the heat recuperative time for water heaters. There is a showroom in the front of the office building for the display of appliances sold to retail customers of LP gas.

The present concern is a combination of twelve older firms some of which bore the name of Rapid Gas and others that of Thermogas. These were merged in 1947 to form the Rapid-Thermogas Company which, with certain phases of the business centralized, is able to operate more efficiently than it was possible in the past. Today, with more than 700 distributors, seven retail appliance outlets and 150,000 customers, the aim of the company is to double the original number of wholesale plants and thus more than double the present business. Elsewhere in the country, dealers have arrived at the point where they now deliver LP gas by tank truck to large consumers who have storage tanks holding half or a full load. In the case of users of extra-large quantities, this system results in lower fuel costs.

Some distributors, familiar with the handling of highly volatile gases, have entered a new field, that of supplying anhydrous ammonia for use as a fertilizer in midwestern farming states. It is plowed into the soil where it undergoes dissociation and provides nitrogen necessary for plant growth. Industrially, it is a source of nitrogen and hydrogen for inert gas welding, heat treating and annealing.

Anhydrous ammonia is processed and transferred from tank cars to storage by means of much the same equipment required in the case of propane-butane gas. The I-R Model LPG compressor, for example, is suitable for unloading the chemical because only cast iron, steel or stainless steel parts are exposed to it. Many standard compressors have copper or brass tubing which, through vigorous chemical reaction, would not only contaminate the ammonia but also cause corrosion and thereby dangerous leakage. Another advantage which applies to both services is that the unit needs no external discharge safety valve because one is incorporated in its high-pressure cylinder which discharges from the exhaust manifold to the intake manifold. Excess pressure is therefore dissipated harmlessly, yet the operator and others nearby are protected from a sudden shower of blinding ammonia or flammable LP gas.

Cylinders containing bottled power (with more than 2500 Btu's packed into each cubic foot) have become a familiar sight, the fuel bringing convenience and comfort to the home and a dependable source of standby power to industry. A wasted natural resource not so long ago, LP gas has even penetrated the field of smoking accessories with a new type of cigarette lighter that burns butane supplied by a small disposable cartridge. It has met consumer acceptance and is now enjoying a brisk sale.

WHERE HISTORY WAS MADE

Completed in 1932, the 60-foot granite pylon at Kitty Hawk was built "in commemoration of the conquest of the air by the brothers Wilbur and Orville Wright conceived by genius, achieved by dauntless resolution and unconquerable faith." The large circle in the picture below is a driveway and the smaller one (at the top) marks the spot where the first four flights were launched. Orville, winner of a coin toss, went first and covered 120 feet in twelve seconds. Five people were present, none of them reporters. When news of the event seeped out, most newspapers suspected a hoax and refused to print it. However, one of them, the Norfolk Virginian Pilot, published a long account written by a cub staff member, Harry P. Moore, who thus "scooped" the world. Kitty Hawk, a small fishing village, was then inaccessible by road, and the Wrights took their plane there by boat. The U.S. Weather Bureau had directed them there when they asked where they could find strong, steady air currents. When the initial flights were made a 27-mile wind was blowing. Kill Devil Hill, from which the machine took off, aided by a runway, was then a shifting mass of sand 90 feet higher than the surrounding land.

N. C. NEWS BUREAU, PHOTO CHARLES BORJES

N. C. NEWS BUREAU, PHOTO GUS MARTIN

Pioneer Birdmen

KITTY HAWK JUBILEE

Jane S. Muller

THROUGHOUT the year 1953, the aviation industry has been marking the Golden Jubilee of the first heavier-than-air powered flight. The rapid advances made by this giant industry belie the events which led up to the historic feat at Kitty Hawk, on December 17, 1903. The four flights made there that day were not the result of haphazard mechanical experiments but rather the culmination of years of deliberate planning by the Wright brothers, Orville and Wilbur.

One source tells us that the Wright boys first became interested in airships when their father brought home a toy helicopter. The influence of this flimsy plaything, soon broken, was quickened by the extensive reading in which they indulged, encouraged by their father, a clergyman deeply interested in the intellectual development of all his children. As teenagers, the lads began to put their mechanical bent and ingenuity to good use in their bicycle shop in Dayton, Ohio, where their inquiring minds absorbed much of practical value.

Somewhere they came across reports on the work of Otto Lilienthal, German engineer and aeronaut known as "the Father of Gliders." The Wrights were fascinated by the accounts of his efforts, and their interest in flying machines sparked into a healthy blaze. With power propulsion as their ultimate goal, the brothers began to experiment with gliders in 1899, hoping in this practical manner to learn the principles of free flight.

The deliberate progression of events preceding that significant December day was indicative of the Wright brothers personalities. With tenacity of purpose, they advanced from research to experiment, turning every mishap and disappointment into an opportunity for further careful study. Because of their single-mindedness they ignored discouraging setbacks.

In the course of their investigations in the field of aviation, the Wrights used and discarded many theories advanced by their predecessors. Octave Chanute, a French civil engineer with whom they corresponded regularly during those years of experimentation, provided them with a set of figures relating to aerodynamics. It was during this period that the brothers became convinced that the published tables on air pressures on curved surfaces were subject to question. This conviction led to the construction in 1901 of a wind tunnel at Dayton where they made measurements of the lift and drag of differently shaped airfoils at angles from 0 to 45°. Those tests

resulted in the revision of the figures and enabled them to achieve powered flight.

When the time came to put a motor in their plane, the Wrights asked the infant auto industry to provide them with a 4-cylinder engine. Told that the manufacturers were too busy, the brothers built their own in six weeks with the assistance of Charles E. Taylor, an employee. The design was based on prevailing automotive practices. Complete with accessories, the 12-hp unit weighed only 170 pounds. The propeller presented a more difficult problem, and to solve it the pair discussed the matter with boatbuilders. Finding that ships' screws were produced mostly by guesswork, the brothers reached the decision that airplane propellers should be constructed on the principles of aerodynamics and worked out a design which made each part an airfoil.

By 1904, Orville and Wilbur believed their flying machine had reached a practical stage and set about trying to find a market for it. Offered to the Government in 1905, it was three years before the War Department announced its intention of purchasing a plane. In 1909 the United States Signal Corps acquired a Wright machine, and military aviation was born. Meanwhile Wilbur had gone to Europe to conduct tests for a French syndicate interested in obtaining sales rights. That was in 1908, but not until World War I was the real value of military aviation brought home to the world. Soon planes were being designed and built for special purposes, and it was only a matter of time before aerial bombardment was an accomplished fact. The struggle for air supremacy had begun.

At the outset the Wright brothers did not envision the great potentialities of the engineering field upon which they had ventured; they believed their invention to have only limited military application. Orville died in 1912, but Wilbur lived through two wars in which aviation was a major factor. Unhappy though he was about the destruction caused by aircraft, still he did not regret the part he had played in its development. During his lifetime, powered flight had not only forcibly demonstrated its capabilities as a fighting arm but also promised achievements far beyond those the average mind could imagine.

The reason the Wrights succeeded in solving the problem of heavier-than-air flying machines that balked others with a more formal education probably lies in the fact that they were deliberate individuals with organized minds. They divided every problem into segments, and not until one had been mastered did they consider the next step in their search for the secret of powered flight. In addition to this dominant trait, the brothers were patient, energetic and ingenious and free of family responsibilities.

AIRCRAFT AIR TOOLS

To serve the burgeoning aircraft industry there was developed a group of entirely new small pneumatic tools (such as the Ingersoll-Rand selection shown) light enough to be handled all day by women and yet powerful and durable. They are now numbered in the thousands in all the larger factories. During World War II, "Rosie the Riveter" became a symbol of the army of female war-plant workers. Pictured are: 1– One of her many fellows driving aluminum rivets with a hammer that weighs barely 3 pounds. 2– The man in the foreground is using a riveting hammer and his companion is running a Multi-Vane drill. 3– An air-buck riveter. The tool's yoke enables it to do its own "bucking up" so that but one operator is required. The tool automatically shuts off after driving a rivet head to a predetermined height. 4– This worker is riveting the tail section of a large plane. The craft in the background is a C-124.

The years between the two world wars were a colorful kaleidoscope of aerial activity—barnstorming, transoceanic and round-the-world hops, endurance tests—all of which resulted in a wealth of data of importance to designers and builders of airplanes. During that time, many of today's major aircraft companies were born. Aerial navigation in America was developing slowly, but soon began to snowball. In 1935, the principal air lines logged 314,000,000 passenger miles, but in 1952 scheduled planes covered 1,114,000,000 miles.

The first transcontinental mail route in the United States was established in 1921 and ran between New York and San Francisco. Three years later the world's first regular night service was inaugurated between Chicago and Cheyenne. The following February Congress passed the Kelly Act, a bill allowing the Postmaster General to make contracts with private lines for the carriage of mail. In 1926 the Air Commerce Act brought air under Federal control, and a civil aviation branch was set up in the Department of Commerce to administer regulations and to take charge of route organization and traffic facilities generally. By the end of the year, fourteen lines were carrying the mail.

The first sacks flown under contract were handled by a line operated by Henry Ford. Among the pioneer systems was Western Air Express, a forerunner of Transcontinental & Western Air, Inc. In 1931 the first foreign airmail service was set up by Pan American Airways, a short run between New York and Bermuda. Four years later planes covered the airmail route San Francisco-Manila and return, which required 122 hours flying time. Service between America and Europe was established in 1939. Reports show that in the fiscal year of 1952 the U. S. Government paid air lines a total of $125,400,000, of which $55,100,000 was for transport and the remainder for subsidies.

The first cross-country air-freight shipment on record was made November 7, 1910, when P. O. Parmelee, a Wright pilot, carried 70 pounds of silk from Dayton to Columbus, Ohio, a distance of 58.3 miles, in 59 minutes, flight time. Charges collected from the Morehouse-Martens mills were based on a rate of $71.42 per pound. Heavy freight cargo did not reach a great volume until 1945, but a Lockheed Aircraft Corporation report predicts it will surpass passenger transportation by 1959. Scheduled passenger lines added cargo flights in 1947, and new freight routes were organized at the same time. Since then the cargo plane has made previously remote parts of the world accessible as a result of both freight drops and pick-ups and has revised not only marketing maps but marketing procedures. New aircraft, especially designed, are being built to satisfy the needs and demands of this branch of the industry.

No one person can be called the inventor of the helicopter, since the principle governing vertical ascent and descent was discovered at different times by different men. Paul Cornu of France and the Breguet brothers made separate attempts to get 'copters off the ground, but managed to attain heights of barely 4 feet. Sikorsky in 1910 tried in Russia, but soon returned to experiments with fixed-wing planes. Others, however, continued to work with helicopters, and in 1922 one built for the U. S. Army rose into the air and drifted 300 feet. The idea seemed to be to make the ship go somewhere beside up and down.

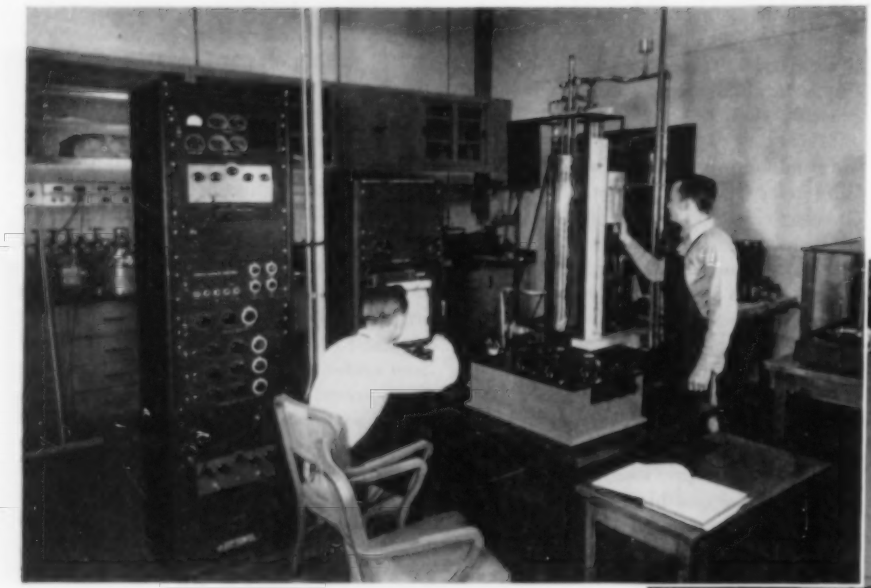
In the 1920's, Juan de la Cierva solved the riddle of stability with his autogyro. But this was really an airplane with shortened wings, a propeller and a motor. On top was a rotor that turned in the air stream and permitted the craft to climb at a steep angle and then to "parachute" to earth. Subsequently, the wings were eliminated, the rotor was power-driven and its head was made to tilt so that the blades could pull the helicopter forward, sideways or backward.

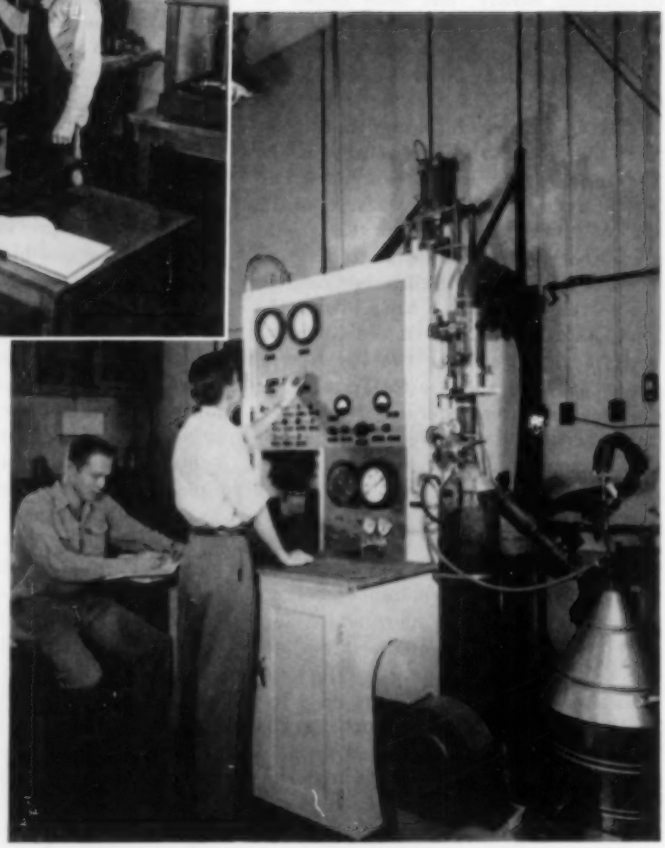
With the beginning of World War II the problem of vertical flight was tackled in many parts of the world and orders for 'copters were placed in the United States by the military services. The craft produced were small as well as fragile, and less than 1000 were put in commission. With the solution of a number of engineering problems at the end of hostilities, helicopters became sturdier, larger, and more powerful. Today they are used by police departments for traffic control and rapid transportation over crowded urban districts; to reach otherwise inaccessible disaster areas; and to carry mail and passengers. In September of this year the world's first international helicopter service began scheduled flights out of Brussels, Belgium, to other major European cities.

"Thrusting forward by giving a backward kick" is the principle upon which the Wrights based their first powered plane, and it is now being applied to craft undreamed of in their day. At present, five types of engines are mainly depended upon for propulsion. There is the reciprocating or piston engine with which the Kitty Hawk plane was equipped. It drives the propeller which, working as an air screw, pulls the flying machine forward fast enough to create a lift over and under the wings to keep it aloft. The turbo-compound engine is a piston engine with an exhaust-driven turbine added. Diverted exhaust gases spin the turbine, from which a drive shaft transmits the energy to the engine crankshaft and then to the propeller, thus increasing the power by as much as 20 percent.

The turbo-prop or jet turbine engine has two sets of turbine blades and drives a propeller. The forward set compresses air, and the rear blades, which are rotated by the expanding gases from the continuous combustion of the air-fuel mixture, turns the drive shaft which spins the compressor and propeller. The plane powered by a turbo-jet engine has no screw, and the forward thrust comes entirely from the force of expanded gases which, escaping to the rear, give an "equal and opposite reaction" that pushes the craft ahead. The last of the three jet-type power plants is the ram-jet engine. Still in the experimental stage, it serves to propel guided missiles. Because it has no compressor to supply air for fuel combustion, it must be launched from a plane or by a rocket. Its initial high speed rams air into the chamber and compresses it. When the air-gas mixture is ignited, the rearward action of the expanding gases drives the jet forward.

The first blind take-off, flight and landing was made Sept. 24, 1929, by (then) Lt. Jimmy Doolittle at Mitchell Field, Long Island, N. Y. Sitting in the completely darkened rear cockpit of a 2-seater monoplane, he took off, soared for fifteen minutes, made two passes at the field and then came in for a perfect landing. This feat was made possible by two gyro-navigational instruments, one giving the direction in which the airplane was headed and the other the angle of ascent or descent. In the 30's, radio apparatus improved and pilots began to rely on their instruments. Direction was maintained with the aid of a compass, a turn indicator warned of any deviation from the course, and a level fixed on the dash showed whether or not a machine was banked. Now, radar surveillance has greatly reduced the danger of approach and landing in bad weather and of collision in midair—in short, measurably increased safety in the realm of flight.





LOW-TEMPERATURE TESTS

These pictures show equipment for studying various engineering materials at extremely low temperatures. In the one at the right a metal specimen, surrounded by refrigerants, is supported within a cryostat behind the panel and subjected to tensile stress by a hydraulic system, the upper part of which is visible above the board. Stress, strain and temperature measurements are obtained from instruments on the board. In the other view heat is being applied electrically to a cylindrical specimen kept at low temperature within the cryostat at the right. Thermocouple junctions placed at intervals along the part measure the temperature gradients resulting from the flow of heat through the material. The man at the table is adjusting the smaller of two potentiometers to determine the current and potential of the heaters. The larger potentiometer is used for temperature readings. The man at the right is using the manometer of the cryostat dewar to read the pressure within the cryostat. An automatic record of the temperature is provided by the recorder in the background. The panel at the left contains servomechanisms for automatic temperature control.

Exploring the Low-Temperature Realm*

Behavior of Engineering Materials in the Frigid Zone Can Now be Observed

A MAJOR low-temperature engineering facility, consisting of a liquid-hydrogen plant and a cryogenic laboratory, has been placed in operation at the National Bureau of Standards site at Boulder, Colo. Known as the NBS-AEC Cryogenic† Engineering Laboratory, the new $3,500,000 installation makes possible large-scale production of liquefied gases which have not previously been available in sufficient quantity for laboratory and industrial development and testing.

The Cryogenic Engineering Laboratory was initiated by Dr. F. G. Brickwedde, chief of the NBS heat and power laboratories, and was designed under his direction, in coöperation with the Atomic Energy Commission, to provide facilities needed for the development and evaluation of cryogenic equipment for use at temperatures near absolute zero. The Bureau's long-standing program of fundamental research on the properties of liquid helium, superconductivity, second sound, paramagnetism, and other phases of low-temperature physics remains at the NBS Washington laboratories.

Low-temperature activities at Boulder are carried on by a staff of 60. Besides the production of liquid hydrogen and liquid nitrogen in unusually large quantities, a program of research and development, directed chiefly towards the improvement of low-temperature equipment, is well underway.

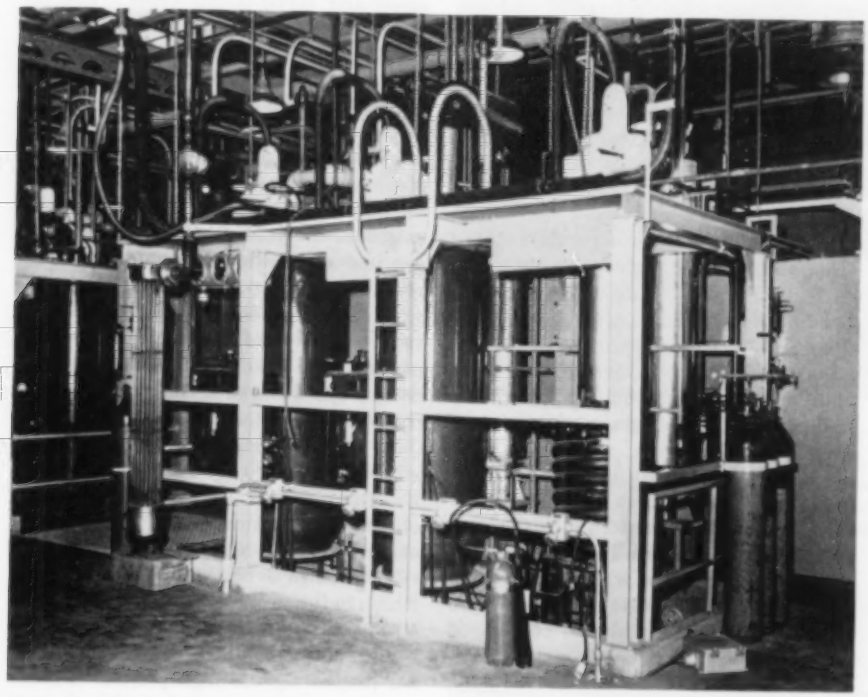
Low-temperature liquefied gases—oxygen, hydrogen, and nitrogen—are finding increased application in industry and national defense, making necessary larger, more convenient, and less hazardous equipment for producing and handling these liquids. As a result, many new and highly complex engineering problems have arisen in the field of low temperature, where much remains to be learned about the behavior of engineering materials. At liquid-hydrogen temperatures, normally trustworthy construction steels become brittle, rubbers lose their elasticity, and the mechanical properties of plastics are greatly altered. In general, there are such marked dif-

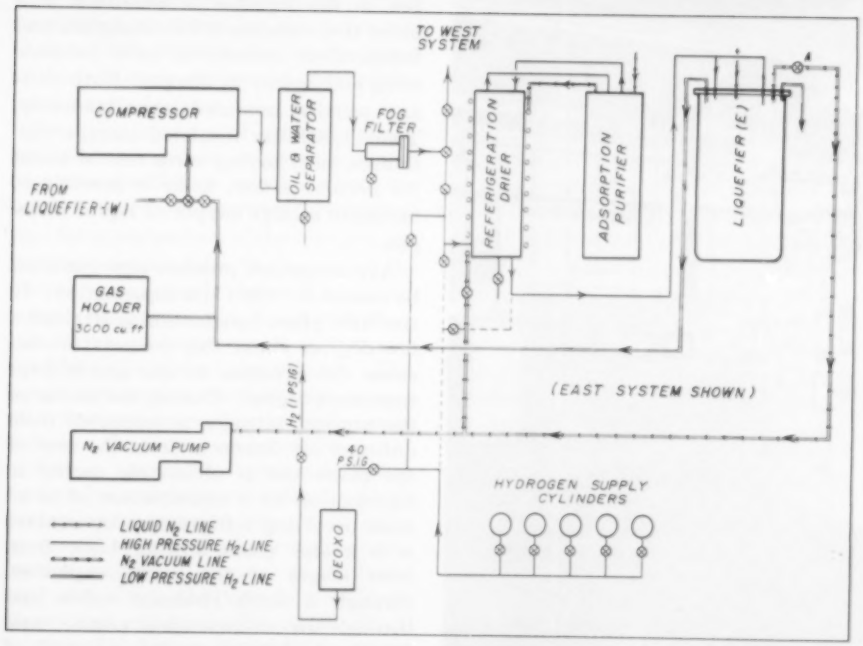
*Summary of Technical Report 1936, National Bureau of Standards

†Cryogenic (from the ancient Greek kryos, ice cold) is an adjective meaning "very cold" or "at very low temperature."

ferences between the behavior of matter at ordinary and very low temperatures that the low-temperature properties cannot be obtained by extrapolation. The NBS-AEC Cryogenic Engineering Laboratory is investigating structural and other engineering properties of matter at low temperatures to provide the needed data and is developing more satisfactory materials and equipment for use at low temperatures.

The Boulder installation is located on a 210-acre tract, the site also of the Bureau's large radio propagation laboratory now under construction. It consists of three principal units: a liquid-hydrogen plant, a liquid-nitrogen plant, and a group of laboratories for research and development. Two large concrete buildings—one housing the liquefying plants and the other for the experimental laboratories and shop—provide 34,000 square feet of floor space. There are also several auxiliary buildings and test sites.





HYDROGEN LIQUEFYING AND PURIFYING EQUIPMENT

The picture shows the essential equipment, other than compressors, involved in liquefying hydrogen. The gas, at 2000 psi pressure, is first purified by removing other gases, oil and water. It is then cooled in heat exchangers by boiling liquid nitrogen and liquefied by expanding it through a Joule-Thomson valve. To insure continuous operation, the equipment is provided in duplicate. The diagram shows the flow through the plant.

Both major buildings are equipped with many safety and anti-explosion devices to minimize the hazards of working with liquid hydrogen in large quantities. The hydrogen liquefying and purifying equipment, which was designed and constructed by NBS, is in duplicate so that the plant can be operated continuously.

Liquid hydrogen—the lightest of all known liquids—has a density one-fourteenth that of water and boils just 20°C above absolute zero (–273.1°C) at atmospheric pressure. Only liquid helium has a lower boiling point. Originally classed by Michael Faraday as a "permanent gas," hydrogen has such a low critical temperature (–240°C) that it was not liquefied until 1898. If hydrogen at ordinary temperatures (above –80°C) is allowed to expand through a throttling valve without doing external work—the so-called Joule-Thomson expansion—the result is not a cooling effect, as with most other gases, but a heating effect. Evidently at temperatures over –80°C, known as the inversion temperature, the thermal energy lost by the expanding hydrogen gas (in overcoming the relatively slight forces of molecular attraction between the lightweight hydrogen molecules) is more than balanced by the heat produced as the expanding gas molecules push one another out of the way. Thus, in order to liquefy hydrogen by expansion, it must first be cooled below –80°C by some other means.

Actually, the further hydrogen is cooled below the inversion temperature before expansion, the greater is the Joule-Thomson cooling effect. For this reason the hydrogen in the NBS hydrogen liquefier, after first being compressed, is precooled with liquid nitrogen to as low a temperature as possible before the Joule-Thomson expansion. Liquefaction is then accomplished by allowing the compressed, cooled hydrogen to expand through the Joule-Thomson valve from a pressure of about 1800 psi to atmospheric pressure. For maximum efficiency in cooling during the course of the process extensive use is made of counterflow "heat exchangers," in which the high-pressure gas is cooled as it passes through many turns of coiled tubing surrounded by low-pressure colder gas moving in the opposite direction from a later stage of the liquefaction cycle.

Commercial hydrogen is transported to the NBS plant for liquefaction in mobile tube banks. The hydrogen is stored until needed in these and in similar stationary tube banks at the laboratory at a pressure of 2100 to 2400 psi. From the storage tubes, the gas flows at reduced pressure (25 to 50 psi) through a tank containing a palladium catalyst, which removes small amounts of oxygen (by promoting the $0 + H_2 = H_2O$ reaction), and then to water-cooled four-stage compressors. Two 3000-cubic-foot

gas holders in the line between the deoxidizing equipment and the compressors provide a ballast for operation of the plant and also serve to maintain a small amount of pressure in the line.

Leaving the compressors at room temperature and a pressure of about 2000 psi, the gas is next purified by means of a system consisting of oil-water separators to remove suspended liquid, a refrigeration drier to remove water and oil vapor, and an adsorption purifier of silica gel cooled to liquid-nitrogen temperature for removal of nitrogen and other gases. After the purified hydrogen has given up some of its heat energy in passing through counterflow heat exchangers, further cooling is attained in the liquid-nitrogen precooler, where the hydrogen passes through coiled tubing immersed in liquid nitrogen boiling at reduced pressure. From the precooler, the gas passes through a final heat exchanger and then through the Joule-Thomson expansion valve, where part of the hydrogen is liquefied by the expansion.

Upon leaving the liquefier, the liquid hydrogen is transferred into storage containers through specially designed vacuum insulated transfer lines. These "pipe lines" have been used to carry the liquid 50 feet or more, and it appears likely that this distance can be greatly extended if desired.

The NBS hydrogen liquefier is unique in that all the heat exchangers as well as the liquid-nitrogen precooler are contained in a single large, vacuum insulated metal dewar having an internal length of 7.5 feet and an internal diameter of 2.5 feet. An identical dewar surrounds the silica-gel adsorption purifier. Inasmuch as the hydrogen liquefying equipment is in duplicate and each liquefier is provided with two silica-gel purifiers for alternate use, the hydrogen plant contains six of the large dewars altogether.

The upper two-thirds of the liquefier dewar contains three heat exchangers and the liquid-nitrogen precooler. These heat exchangers are in parallel and are equipped with adjusting valves which permit distribution of the flow of entering hydrogen between the exchangers in such a way as to obtain maximum efficiency in the cooling process. The lower third of the liquefier dewar serves as the liquid-hydrogen collection pot. It also contains the final heat exchanger and the Joule-Thomson expansion valve. The portion of the hydrogen which was cooled but not liquefied in passing through the expansion valve is used as a refrigerant in the final heat exchanger and in one of the initial heat exchangers, while the liquid-nitrogen vapor from the precooler is the refrigerant in the two other heat exchangers.

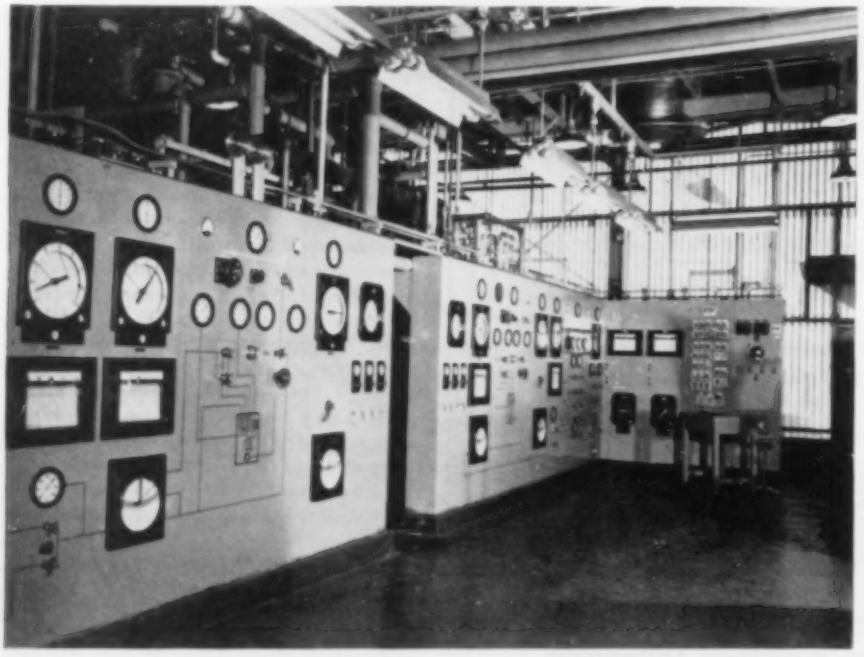
The refrigeration drier and silica-gel adsorption purifier are arranged as a unit. Hydrogen gas enters the drier case at room temperature and passes over heat-exchanger tubes where it is cooled by outflowing gas inside the tubes. The water and oil impurities are condensed out as the gas flows through the drier toward the nitrogen purifier. The gas is finally cooled to liquid-nitrogen temperature by passing through a coil submersed in liquid nitrogen in the purifier dewar. At this temperature nitrogen gas present as an impurity in the hydrogen is readily adsorbed by the silica gel as it flows through the silica-gel coil.

For efficiency and convenience of operation, the hydrogen liquefaction system is extensively equipped with automatic instruments, recording devices, and servo-mechanisms. For example, level indicators and controllers developed by NBS measure the liquid-hydrogen level and automatically maintain the proper level of liquid nitrogen in the adsorption purifier dewar and in the precooler. An automatic control instrument regulates throttle valves in the vacuum pumping lines to keep the pressure over the pots of boiling liquid nitrogen just above the triple point for maximum cooling without freezing the nitrogen. Another automatic instrument controls the level of hydrogen within the gas holders, thus insuring that new hydrogen gas flows into the system at the same rate as liquid hydrogen is taken out. The nitrogen content of the hydrogen is measured by a thermal conductivity apparatus. Finally, whenever a part of the liquefaction plant is not operating properly, a general annunciation system rings a bell and flashes a light which indicates the particular part of the equipment that must be investigated.

Liquid nitrogen (99.7 percent pure) for precooling the high-pressure hydrogen in the liquefier is produced in a plant that consists of two complete and independent commercial units for purifying and liquefying the gas. Both units are usually operated simultaneously. Two 11,000-liter insulated storage containers, each having a loss rate of about 1.5 percent a day, make it possible to maintain a large supply of liquid nitrogen.

At atmospheric pressure nitrogen must be cooled to –196°C for liquefaction. In the NBS plant liquefaction is attained a few degrees above this temperature because the pressure of the gas is kept somewhat higher. During the course of the process, nitrogen is separated from ordinary air drawn in from the roof of the plant and is ultimately cooled to liquefaction by a combination of processes involving refrigeration by contact with colder gases flowing back from later stages of the cycle, expansion through a Joule-Thomson valve and through an air-expansion engine, and fractional distillation for removal of oxygen and further liquefaction.

The air from which the nitrogen is to be separated is first compressed to 3000 psi in five stages. Between the second and third compression stages it is run through a tank containing a solution of



CONTROLS FOR HYDROGEN LIQUEFACTION

The two panel sections at the left function alike and are used alternately, depending upon which of the two liquefiers is in operation to regulate the flow of hydrogen through the apparatus. The larger dials record and control the level of the liquid hydrogen and liquid nitrogen in the liquefiers and purifiers, regulate pressure and record temperature. The smaller dials indicate pressure.

sodium hydroxide for removal of carbon dioxide. After three more compression stages have brought the pressure to 3000 psi, the gas flows through a drier containing activated alumina for removal of moisture.

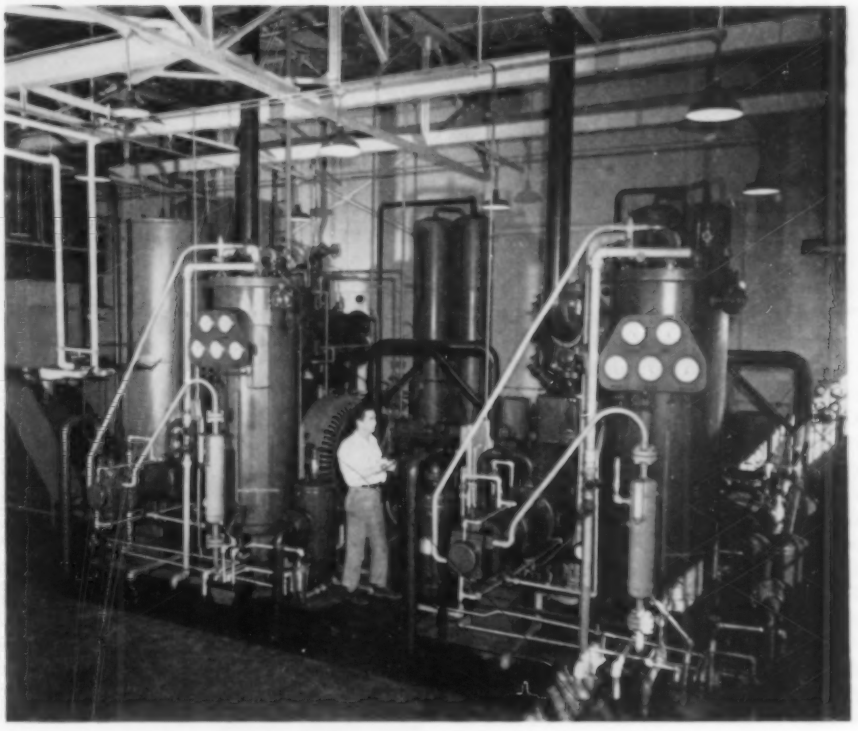
With carbon dioxide and water removed, the gas now consists essentially of nitrogen and oxygen at relatively high pressure. It next enters a heat exchanger, which it leaves by two different lines. One line is connected to the cold end of the heat exchanger—about −145°C—the other is connected at a point where the temperature is about 0°C. Through this latter line the high-pressure gas enters an expansion engine. Here its pressure is lowered as it does work against reciprocating pistons. The work thus developed is absorbed by an electric generator, and this loss of energy from the gas results in a lowering of its temperature to about −140°C. Further temperature reduction to the liquefaction point is then obtained by passage through an auxiliary low-pressure heat exchanger.

The line leaving the cold end of the main heat exchanger goes to an expansion valve, where the pressure is reduced to about 75 psi. The temperature is correspondingly reduced to the liquefaction point by the Joule-Thomson cooling effect, causing a fraction of the air to liquefy.

The expansion engine furnishes a sizable amount of refrigeration which indirectly serves to precool the air going to the expansion valve, thereby increasing by several times the efficiency of the process. Optimum performance of the system is obtained by regulation of the amount of air taken by the expansion engine. This is controlled by the speed of the expansion engine and the time the intake valve is open.

The two streams of partially liquefied nitrogen-oxygen mixture join and flow to a distillation column, where the liquid nitrogen is separated. Refrigeration for condensation of the nitrogen vapor that accumulates in the top of the distillation column is obtained by piping some of the oxygen-rich liquid in the bottom of the column into a jacket surrounding the top of the column. The liquid nitrogen is continuously tapped off into a reservoir and periodically transferred to the large storage tanks.

Among the many automatic safety devices is a hydrogen-gas indicator which continuously samples the air at eight points. Whenever the hydrogen concentration reaches 10 percent of the lower explosive limit, this device sounds an alarm and automatically closes off all sources of hydrogen. In addition, a ventilating system normally changes the air in the building every two minutes and is automatically speeded up to effect a complete change once a minute when the hydrogen alarm sounds. Other safety precautions include conducting floors to eliminate static sparks, a system that measures the concentration of oxygen in the hydrogen with a sensitivity of 2 parts in a million, and means for venting hydrogen to the outdoors in an emergency.



FIVE-STAGE COMPRESSORS

These duplicate machines compress air to a pressure of 3000 psi as a preliminary step towards liquefying and then distilling it to obtain liquid nitrogen. The latter, in turn, is used as an aid in cooling hydrogen so that it can be liquefied. The compressors were built by Ingersoll-Rand Company and each is driven by a 300-hp motor.

Research and development at the Cryogenic Engineering Laboratory are directed principally towards safer and more convenient means for handling liquid hydrogen and towards increased knowledge of the properties of materials at very low temperatures. Efficient design of low-temperature equipment requires information on the mechanical and heat-conducting properties of many metals, alloys, and plastics over a temperature range extending from room temperature down almost to absolute zero. The Bureau is now developing apparatus for low-temperature measurement of the tensile and impact behavior and fatigue properties of these materials. Such data are at present very meager and are mainly confined to those materials and temperatures encountered in aircraft design. As a first step towards the accumulation of thermal conductivity data, apparatus has been designed which provides results in the temperature range from 2° to 300°K. The new apparatus is expected to make possible more rapid collection of data without loss of accuracy.

Design of a large-capacity cryostat is also underway. This equipment will be used to provide a controlled low temperature environment for many different kinds of tests of low-temperature materials. The Bureau is also working on the design of more efficient insulated lines for transfer of liquefied gases. A major part of this project is the development of valves, fittings, and couplings that will permit easy assembly, extension, and control of flow.

Recently the efforts of the Bureau to obtain liquid para-hydrogen on a large scale have met with signal success. Liquid hydrogen as usually produced has a high concentration of the molecular form known as ortho-hydrogen, in which the diatomic molecules have the two nuclear spins oriented in the same direction. But the low-temperature equilibrium form of hydrogen is nearly pure para-hydrogen, in which the nuclear spins in each molecule are opposed. Thus, ordinary liquid hydrogen slowly changes to the para form with an accompanying evolution of heat, and this heat causes a serious loss of liquid hydrogen by evaporation (about one percent per hour for fresh normal liquid hydrogen). One of the liquefiers at the Cryogenic Engineering Laboratory has been equipped with a special catalyzing chamber which results in the production of almost pure liquid para-hydrogen. This liquid hydrogen, being free of exothermic ortho-para conversion, has excellent keeping qualities and can be stored with little loss for many days.

Christmas Cards and Legends

YULETIDE customs are probably more numerous and more colorful than those surrounding any other holiday. This is true, perhaps, because Christmas is well-nigh a universal feast day, and the traditions in which it is cloaked have come down to us from nearly every part of the world. The origin of some of the customs is lost in antiquity, according to Wrightson Christopher, general manager of Rust Craft Publishers, who collects Christmas legends as a hobby.

The word yule, Mr. Christopher has discovered, stems from ancient northern peoples who believed that the sun revolved around the earth and reached its solstice in the winter. This cycle was known to them as *huveol*, altered through the years to yule. It was among them, Mr. Christopher tells us, that the ceremonial burning of the yule log took place. A pagan rite that was celebrated by the Romans, including a processional and lighting of candles, was adopted by early Christians and made a feature of the festivity commemorating the birth of Christ. Later, it was combined with the winter solstice celebrations in other parts of Europe.

PHOTO, BETTMANN ARCHIVE

FIRST CHRISTMAS CARD

Facsimile of the earliest Yuletide greeting card of record produced in 1842 by W. M. Egley, a London engraver's apprentice. The first American card is reputed to have been made in Pennsylvania by J. F. Rudolph. The National Association of Greeting Card Publishers estimates that there are more than 25,000 designs to choose from in an average year.

CARD OF 50 YEARS AGO

This lithograph in four colors is typical of the religious motifs on Christmas greetings of that era. It was produced by the Stecher Lithographing Company, of Rochester, N.Y.

The Christmas tree is believed to commemorate a very old Arabian legend that plants flowered and trees bore fruits on the eve Christ was born. According to Mr. Christopher, it is not a world-wide symbol of that holy day. As a matter of fact, he says the crib or crèche is more widely known and is found in many homes at Christmastime just as the tree is in northern Europe and the United States. St. Francis of Assisi is credited with having conceived the idea of displaying an image of the Christ Child in a manger at Christmastime. At midnight on that hallowed eve early in the thirteenth century, it is related, he and his followers celebrated mass and sang hymns to honor the Infant Jesus lying in a crèche in a cave near the monastery where he dwelt not far from the small village of Garcia, Italy.

The spirit that prompts the bestowing of gifts at yuletide is far different today than it was at the time of the Roman emperors. Mr. Christopher discovered that their subjects were "invited" to give them presents at that holiday season more for selfish reasons than as a religious observance. In eastern and southern Europe, Santa Claus shares his reputation as a gift-bringer with the wise men, in Hungary with angels, in Poland with stars, in Greece with St. Basil and in Denmark with an elf—*jule-nissen*. A comparative newcomer to the Christmas scene, Santa actually is St. Nicholas, as immortalized in W. Clement Moore's *A Visit from St. Nicholas*, better known as *The Night Before Christmas*.

The legend of St. Nicholas has its basis in fact, we are told. In the ninth or tenth century, a child named Nicholas was born to a wealthy bishop and his wife in Asia Minor. When the parents died, Nicholas gave away his inheritance and, after his death, was named patron saint of children, whom he loved. First buried at Myra, Asia Minor, and then moved to Bari, Italy, his tomb became a place of pilgrimage in the belief that his mortal remains effected cures and performed miracles. The round, jolly Santa we are accustomed to seeing at Christmastime is the creation of Thomas Nast, famous American political cartoonist, who, in 1863, illustrated *The Night Before Christmas*. It was Nast who located Santa's home at the North Pole and gave him a sleigh with reindeer.

The first greeting card of which there is knowledge conveyed a New Year's message and was printed from a woodcut in Germany in 1450. It pictures the Christ Child standing in a galley manned by a crew of angels, with Mary his mother seated at the mast. Around 1700, Christmas "pieces" became a fad in

England. Presented in a gay manner befitting the holiday, they were specimens of children's penmanship showing the progress they made in school. Not until 1842, however, did a real yuletide card appear. Then William Maw Egley, 16-year-old English engraver's apprentice, made a copper engraving depicting scenes of Christmas festivities all entwined in ivy and roses. The card is now on display in the British Museum. Because it had been misplaced and not discovered until 1941, credit for being the first to design such a greeting had been given to John C. Horsley, member of the Royal Academy, who was commissioned by Sir Henry Cole to create one for him in 1846. One thousand were printed and sent out. It appears, however, that Horsley was preceded by J. F. Rudolph, of Lancaster County, Pennsylvania, who, according to Cornelius Weygandt, an authority on matters relating to eastern Pennsylvania, made Christmas cards in 1845. These were oval-shaped and bore the legend "Unto you is born a Saviour which is Christ the Lord."

By 1860, the manufacture of greeting cards was a flourishing industry in England. Meanwhile, Louis Prang, who emigrated to the United States from Germany about 1850 and worked for several years as a wood engraver, used his savings of $250 to open a lithographing shop in Roxbury, Mass. At the Vienna Exposition in 1873 he displayed a flowered business card that attracted so much attention that the wife of one of his business associates suggested replacing the firm name with a Christmas message. Prang sold such cards in England during the 1874 season and exhibited them the following year in America at the Philadelphia Centennial. They were fancy affairs which could be bought with or without silk fringe.

In 1880, Prang sponsored the first of four contests for Christmas-card designs. First prize was $1000, and went to Rosina Emmett for her picture of singing choir boys with an angel and shepherd in the background. Twenty-five other designs were purchased that year. Elihu Vedder, several of whose paintings hang in the Library of Congress, was the recipient in the 1881 competition in which 2500 pictures were entered. The following year two first prizes were awarded, one by judges and the other on the basis of public opinion. Both were won by the same entry. Prang was known to have paid as much as $2000 for a single design. Today his cards are collectors' items. He also planned one of the first art courses for schools, and is credited with having exerted great influence on art appreciation generally.

Over the years, greeting cards have reflected tastes and customs. In the 1860's and 70's, except for the sentiment printed on them, they lacked Christmas feeling. During the next decade, however, a holiday spirit was apparent with skating scenes, stagecoaches, carol singers and angels, all presented in the Victorian manner. The Dickens influence was dominant. By the turn of the century, art standards in yule greetings unfortunately had begun to decline and the picture postcard, imported mostly from Germany, was popular. Christmas poems that struck the public fancy about 1910 showed marked signs of betterment when the First World War halted the flow of penny postcards from abroad. Noted artists took an interest once more in the greeting-card medium, and models of ships prevailed in the early twenties. The Prang lithographic process that had

By any other name . . .

The French say
Joyeux Noel

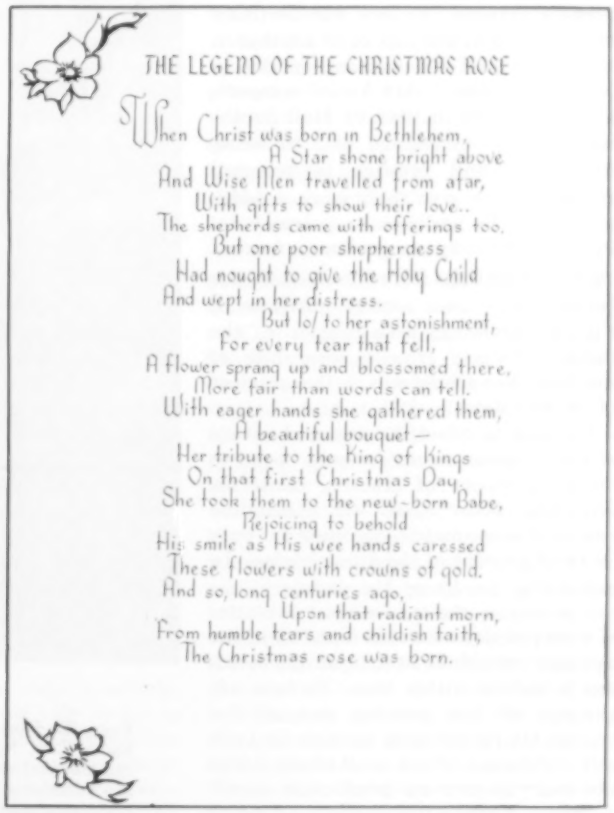
The Italians,
Buon Natale

In Swedish, it's
God Jul

The Germans say
Froeliche Weihnachten

To the Portuguese it is
Alegre Natal

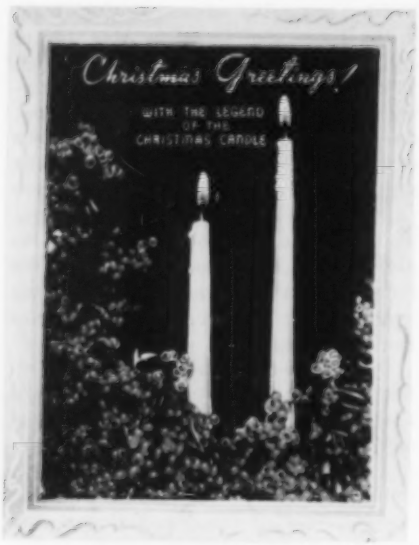
The Spanish say
Felices Pasquas


THE LEGEND OF THE CHRISTMAS ROSE

When Christ was born in Bethlehem,
A Star shone bright above
And Wise Men travelled from afar,
With gifts to show their love..
The shepherds came with offerings too,
But one poor shepherdess
Had nought to give the Holy Child
And wept in her distress.
But lo! to her astonishment,
For every tear that fell,
A flower sprang up and blossomed there,
More fair than words can tell.
With eager hands she gathered them,
A beautiful bouquet—
Her tribute to the King of Kings
On that first Christmas Day.
She took them to the new-born Babe,
Rejoicing to behold
His smile as His wee hands caressed
These flowers with crowns of gold.
And so, long centuries ago,
Upon that radiant morn,
From humble tears and childish faith,
The Christmas rose was born.

LEGEND OF THE ROSE

Some of the cards produced by Rust Craft Publishers feature old legends, on which the firm's general manager, Wrightson Christopher, has done much research. A typical example is shown.



CANDLE CARD

Candles are closely associated with Christmas customs and religious services in many lands and are a popular design for cards. One of the many legends concerning them is printed on the inside of the card pictured.

made it possible to use as many as twenty colors on one card came into its own again in the early 1930's and was improved upon.

Today, floral designs are most popular, with winter scenes and "bold" greetings second and third choice. Pictures of a religious character are in increasing demand; in fact, the Nativity was featured in one aspect or another in more than half the winning entries in the 1952 Hallmark Art Award competition established in 1949 by Hall Brothers, Inc., to encourage art, to bring recognition and prestige to talented artists, and to give their work a wider audience. In addition to original designs, the industry is reproducing famous religious paintings from the Renaissance period. The total annual purchase of Yuletide greetings with religion as the theme reflects a growing awareness of the fact that Christmas is the greatest of all holy days.

In order to offset the seasonal nature of the business, manufacturers began to build up stocks of greeting cards for occasions other than Christmastime which, it is estimated, accounts for only 30 to 45 percent of the annual sales. In expanding its lines, the industry has capitalized on the tender susceptibilities of most people and on the inability of the average individual to express the sentiments welling within him. To take advantage of the growing demand for reasonably priced cards suitable for both sad and joyous events of all kinds, it was necessary to increase production speed.

Many cards have colored edges, a pleasing feature. Originally, the pigment was applied by hand, a time-consuming and costly process. Hall Brothers, Inc., solved this problem by means of the airbrush. To do the work, the operators, usually girls, fanned out the cards, leaving only the narrow edges exposed to receive the color, which they sprayed on with ease and at low cost while maintaining quality. With the handy tool it was also possible to make a French border, a wide base of one color and a narrower one on top of another, and to apply watercolors by aid of stencils to motifs printed on the cards. Today, however, because of the many different grades and kinds of paper used, most cards are lithographed and the airbrush serves only in the manufacture of the more expensive lines and for special orders.

Despite technical advances in high-speed presses and printing, Anderson-Lamb Photo Gravure Corporation still follows the method by which Egley produced the first Christmas card in 1842. The design is engraved by hand on a thin copper plate, which is then inked and wiped, also by hand. Impressions are taken on dampened paper on a hand press. For two years the Duke and Duchess of Windsor had their yuletide greetings made by this firm, which includes a number of prominent New York men among its clientele. The work is really a sideline with the company, which specializes in printing paintings and rare drawings. One amateur artist has his watercolors reproduced actual size.

Sales of greeting cards have increased enormously through the years. According to recent estimates, close to 3.8 billion will be purchased in 1953 in the United States alone at a cost of $350 million. This represents an increase in demand of 15 percent as compared with last year; 25 percent over 1951; and a three- to fourfold gain since 1939.

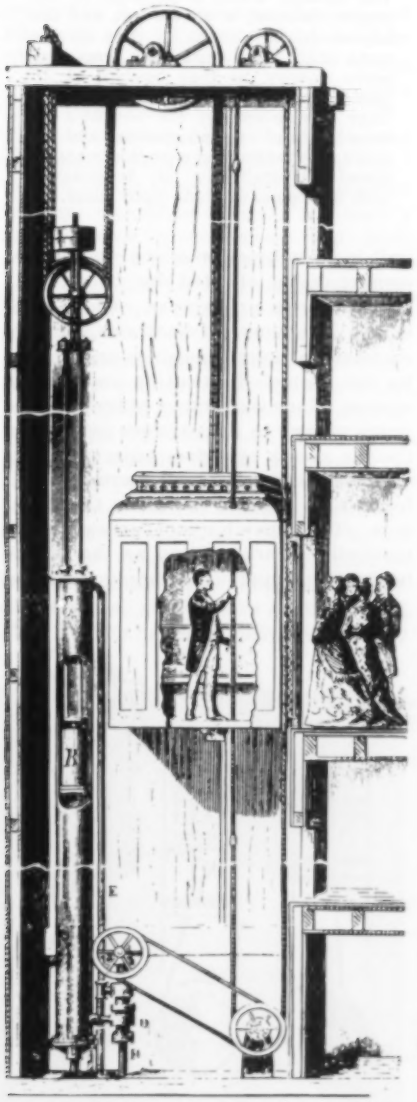
PHOTO BY BERNARD G. CAVANAUGH

CHRISTMAS TREE SEEN BY MILLIONS

Every December a stalwart evergreen, aglitter with tinsel and lights, stands in Radio City, New York, a mecca for Gotham sight-seers. The largest and most symmetrical specimen that can be found is selected in the field during the preceding summer and, at the allotted time, is cut down, carefully transported, erected and decorated. The picture shows the 1952 tree, called the largest trimmed one in the world, rising 85 feet amid skyscrapers. One might expect such a giant to come from the north woods, but actually it grew on the Tranquillity Farms, in the same New Jersey county where this magazine is published. It was a Norway spruce 60 years old.

He Reached for the Sky

THE passenger elevator, which made the skyscraper possible, is an even 100 years old. Its forerunner, a freight carrier, was devised in 1852 by Elisha Graves Otis, then master mechanic for the Yonkers (N.Y.) Bedstead Manufacturing Company, for transporting heavy equipment to the top floor of the factory. It was essentially a hoist, and hoists of one sort or another had been known for perhaps 2000 years. However, the one conceived by Otis included a safety feature that fitted it for carrying people. If the rope broke, a piece of steel wagon spring would snap out against a ratchet and hold the load. That addition took the hazard out of vertical transportation and founded a large industry.



SLOW BUT SURE

An early elevator, which the operator set in motion by tugging on the rope. Others were powered by the use of steam or water.

Otis, a 41-year-old bearded Vermont Yankee, at first didn't realize the importance of his creation. He had, in fact, about decided to go looking for gold in California when a Mr. Newhouse asked him to make two of his "safety hoisters" for a building at 275 Hudson Street, New York. In order to make them, Otis opened his own shop in Yonkers on September 20, 1853. That was the seed of the present Otis Elevator Company which has installed lifts in nine of New York's ten highest structures and only a few months ago contracted to put 30 elevators, worth $3,000,000, in the new Prudential Building in Chicago, Ill.

A lull followed the initial order, and Otis resorted to showmanship in 1854 to stimulate interest in his product. At the Crystal Palace Exposition, at Fifth Avenue and Forty-second Street, where the New York Public Library now stands, he had himself hoisted to the ceiling on a platform and then ordered the rope cut. The wagon-spring safety lock snapped into place, holding the platform aloft. Otis doffed his tall Vermont hat and called down to the spellbound watchers, "All safe, gentlemen, all safe!"

Orders soon began coming into the little shop of "the safety elevator man," as he came to be known. A leaflet put out in 1855 announced that Otis was prepared to construct elevators that would lift from 500 to 8000 pounds at prices ranging from $350 to $8000 each and install them in complete running order in buildings not more than five stories high.

Those early lifts were powered either by steam, water or human muscles. In the first-mentioned type, the car's hoisting rope was passed over a sheave and wound on a drum turned by a steam engine. In the first hydraulic models the rope was attached to a bucket that traveled in a standpipe as high as the elevator. By adding or discharging water, the bucket was made heavier or lighter than the car, causing the latter to ascend or descend. The water was taken from a tank at the top of the shaft and the discharge from the bucket dropped down the standpipe into a reservoir in the basement from which it was pumped back up so it could be used over and over.

Until the first lifts were available, cities had grown upward only as far as people were willing to climb stairs. The coming of the first high-speed hydraulic elevator in 1878 made high buildings economically possible for the first time and ushered in the skyscraper era. During a strike of elevator operators in New York a few years ago, most firms occupying the upper floors of tall buildings had to close down. Electric power for elevators became standard in the 1890's.

E. G. OTIS

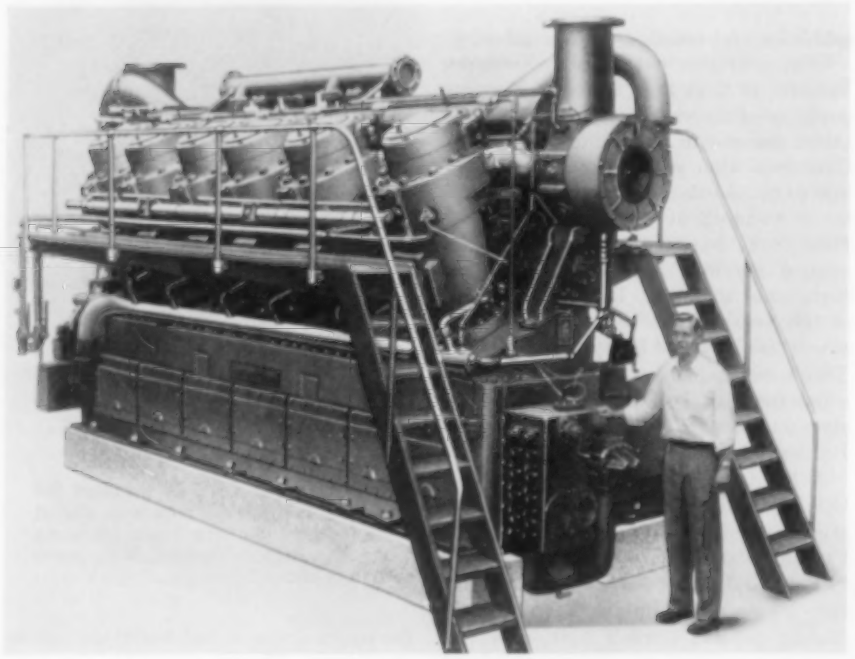
Born August 3, 1811, he invented the world's first safe elevator and started the industry that now bears his name in a tiny shop in Yonkers, N.Y., just a century ago.

Otis was a victim of a diphtheria epidemic in 1861, but his two sons, Charles R. and Norton P., carried on the business which, in 1898, was incorporated as the Otis Elevator Company. At the Paris Exposition of 1900 the firm introduced its amazing new Escalator, the name of which was for years an Otis trademark.

As cities began to build skyward, vertical transportation assumed great importance. In its April, 1909, issue, COMPRESSED AIR MAGAZINE reported: "It is estimated that in the Borough of Manhattan there are about 10,000 passenger elevators and 12,000 for freight service. In 26 office buildings of eighteen stories and over, with a rentable area of 116 acres, there are 231 elevators, which travel between 4000 and 5000 miles of vertical distance each day and carry 615,000 passengers. There are 8000 elevators in office buildings alone." By way of contrast, Otis officials expect 23 billion people to ride 550 million miles in its elevators throughout the world in 1953.

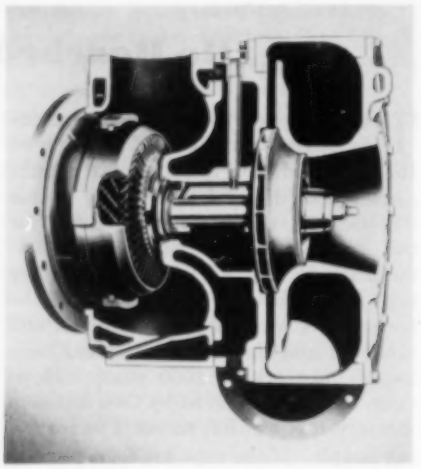
Through the years, Otis engineers have concentrated on removing the human element from elevator operation. A self-leveling mechanism developed in 1915 was followed by automatic control of single cars. In 1948 they introduced the "autronic" system which, through the medium of an electronic brain, coordinates the movements of whole banks of cars, making changes in accordance with variations in traffic demands. Elevators now travel at a speed of 1400 feet per minute, and hazards have been reduced to such an extent that vertical transportation is called the world's safest.

Turbochargers Boost Compressor Output



FIRST OFF THE PRODUCTION LINE

Shown here is one of the compact 2000-hp turbocharged gas engine-driven compressors being built by Ingersoll-Rand Company. The four compressor frames are all on one side (not shown) and are 5 feet apart to make the cylinders and engine readily accessible. One of the integral turbochargers is seen at the right above the man's head. Units of the 412 KVS Type have a wide field of application in the gas-transmission, petroleum and chemical fields.



TURBOCHARGER SECTION

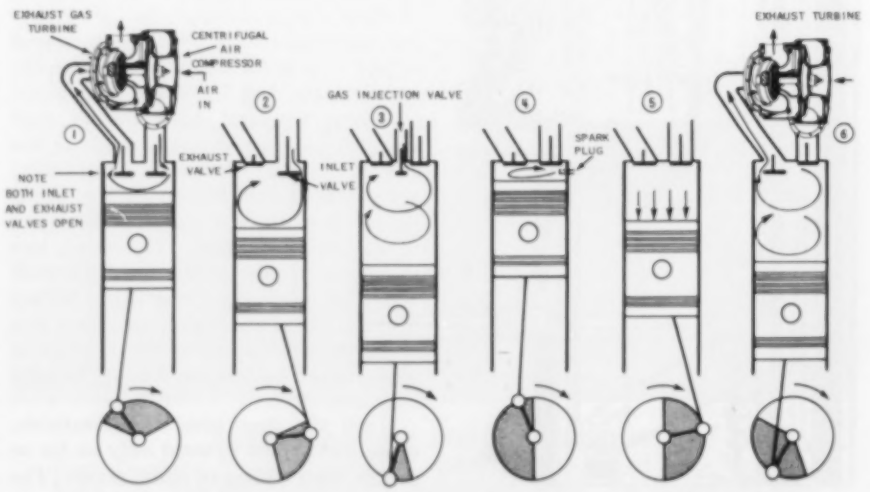
Two of these machines are used on each gas engine-driven compressor. The turbine, which is powered by the engine exhaust, is on the left, and the blower (right) driven by it is on the same shaft. The units have ample reserve energy, as they operate at 25 percent under their rated capacity. They are served by the engine's lubricating and cooling systems and require no attention because they change speed automatically in accordance with the demands made upon them.

YEARS of research by Ingersoll-Rand Company engineers have culminated in the development of a 2000-hp compressor driven by a turbocharged 4-cycle gas engine. The company began work in this field in 1943, and after applying supercharging to three full-size engines began shop tests on the first commercial turbocharged gas-engine compressor. These tests lasted for two years, and at the end of that period the Type 123 KVS, as it was designated, was installed in a gas pipe-line station and has been operating efficiently ever since. It was overhauled a few months ago in the presence of factory engineers and found to be in excellent condition after 10,400 hours of service.

The new unit, the Type 412 KVS, represents improvements in design and differs from the earlier model in that it has four instead of three compressor frames which are spaced farther apart to permit the use of larger cylinders. Its twelve power cylinders, arranged in two banks, are closer together in relation to one another, thus saving floor space by reducing the width 2½ feet. These advantages, together with moderately slow power- and compressor-piston speeds, are largely attributable to a unique crankshaft with compound crankpins.

According to J. J. Janzen, head of the Ingersoll-Rand gas-engine department, the 412 KVS has been field tested for more than a year, and of seventeen on order most have been shipped and the others are scheduled for early delivery. Up to this time, the largest compressor driven by a 4-cycle gas engine was rated at 1320 hp; now, by means of turbocharging, the rating has been increased to 2000 hp.

Turbocharging as applied to the new unit is a combination of scavenging and supercharging effected by two Elliott turbochargers or blowers, one at each end of the engine. Of small size, they are enclosed in bolted housings and served by the engine's lubricating and cooling system. Each is operated entirely by the waste energy in the exhaust gases from the six power cylinders adjacent to it, and both discharge into a common manifold which delivers the air to the cylinders. The superchargers function automatically—start as soon as the engine begins to exhaust—and supply more and



HOW THE TURBOCHARGED ENGINE WORKS

From left to right: 1, Air from the blower manifold sweeps through the cylinder, purging the exhaust gases and cooling the cylinder, piston and valves; 2, the cylinder is filled with blower air at 4 psi pressure; 3, fuel is injected into the cylinder; 4, the air-gas mixture is compressed and ignited; 5, the fuel mixture burns, driving the piston down; 6, the exhaust gases pass to the turbine to drive the blower.

more air as the engine picks up speed.

As an accompanying drawing of the working cycle of each power cylinder shows, air from the blower manifold sweeps through the upper section of the cylinder and out of the exhaust valve at the end of the exhaust stroke, purging the cylinder of burned gases and cooling it, as well as the piston and valves. When the exhaust valve closes, the inlet valve remains open and the cylinder is filled with air at 4 psi pressure. A butterfly damper in the air line between the manifold and the cylinder throttles the flow when the load is light.

Blower air for turbocharging does not have to be precooled or aftercooled because of its low discharge pressure and because of the engine's low compression ratio, among other factors. The compression ratio is only 6:1, resulting in a compression pressure of 225 psi and a firing pressure of 600 psi at 2000 bhp. The rated bmep (brake mean effective pressure) is 121.6. This is also moderate and is said to insure troublefree continuous operation and enables the engine to handle unavoidable overloads without danger of detonation even with high ambient temperatures.

Other advantages claimed for the improved supercharged compressor are fuel economy, which is estimated at 7600 Btu per brake-horsepower-hour at full load, 8000 at three-quarter load and 9000 at half load; low heat rejection with consequent savings in water- and oil-cooling equipment; and elimination of outside drive for the blower turbines.

Moles Will Honor Steers and Maxon

OUTSTANDING service to the industry will be recognized on February 3, in New York City, when The Moles, an organization of men engaged in heavy construction, confers its 1954 awards on J. Rich Steers, a member, and Glenway W. Maxon, a nonmember. They will be the fourteenth pair to join what is considered to be the industry's most distinguished honor roll.

Mr. Steers' belief that "good personnel plus good equipment equals good job," as well as his keen interest in company workers regardless of rank, has been a strong factor in the success of J. Rich Steers, Inc., a New York concern, which has accounted for approximately $250 million worth of construction in the last six years.

A resident of Huntington, N. Y., Mr. Steers is a veteran of World War I and was graduated from Princeton University in 1920. The next three years he was employed mostly in the machine shop and factory of the Bayonne Bolt Corporation and then as assistant timekeeper by Henry Steers, Inc., founded by his uncle and father in 1900. After that he worked on the design and construction of a sand and gravel plant at Northport, N. Y., which has remained in the family and of which he is president. In 1936, following the death of his father, he became president of J. Rich Steers, Inc. (The firm name was changed by J. Rich Steers, Sr., in 1929 upon the death of Henry Steers, the uncle.)

During the depression years the company was engaged on such big projects as the Newark improvements on the Pennsylvania Railroad, which included two sections of the city's subway; constructing the bulkhead and fill forming the Bayonne Port Terminal, now the Bayonne Annex of the U. S. Navy Yard; and building three sections of the East River Drive in New York City.

The onset of world emergency conditions brought large rush jobs to the firm, and before the attack on Pearl Harbor it had reconstructed Shipways No. 2 at the Brooklyn Navy Yard from which the battleship *Missouri* was launched three years later. That was followed by the building, in conjunction with Walsh Construction Company and others, of Drydocks Nos. 5 and 6 at the same base. After Pearl Harbor, two big piers and other structures were added to this contract, which represented an outlay in excess of $75,000,000. The largest defense project carried out singly by Steers and completed in record time because of the role it was to play in the invasion of Europe was a 2¼-mile ammunition loading pier at Leonardo, N. J. In addition, the firm, in coöperation with the Walsh company, built more than 1200 invasion barges.

Since 1947, Mr. Steers has been giving his personal attention to several big undertakings in the Mediterranean area. The first of these foreign operations was a contract with the U. S. Corps of Engineers for the rehabilitation of the three main Greek harbors and the Corinth Canal, a joint venture with Grove, Shepherd, Wilson & Kruge. The others were the building of a high-frequency radio station at Tangier and a naval base at Port Lyautey, both in Morocco, and the Wheelus Air Force Base at Tripoli, Libya.

Mr. Maxon is president of Maxon Construction Company of Dayton, Ohio, which he helped to form in 1928. He is being especially honored for his firm's success in sharing earnings, first, through the establishment in 1930 of a bonus system for men from foremen up and, second, through a trust fund, started in 1944, for all employees with a record of three or more consecutive years with the company.

During the quarter century Maxon has been in business, it has completed approximately $700 million worth of construction, and at the beginning of the current year had another $200 million worth underway. Dams, locks, and bridges, principally on the Ohio and Mississippi rivers and their tributaries, have figured prominently in its operations, but defense plants, inland shipyards, highways, railroad structures, and installations for the Atomic Energy Commission have been among the assignments that have sent Maxon crews to many parts of the United States. The firm has also designed and built towboats and barges, as well as specialized floating equipment for river work of different kinds.

A native of Texas, Mr. Maxon studied civil engineering at the Universities of South Dakota and Cincinnati and in 1905 entered the employ of the U. S.

J. RICH STEERS

GLENWAY W. MAXON

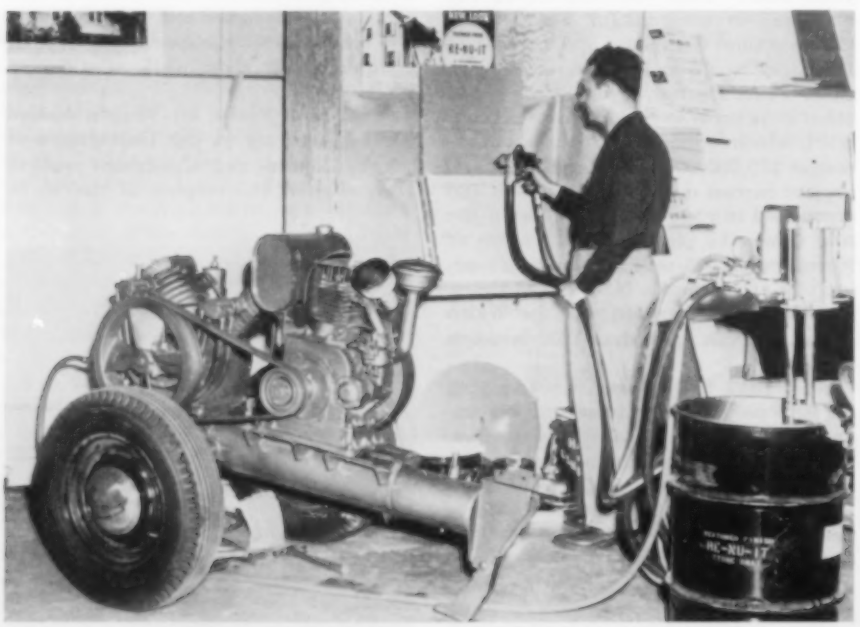
Army Engineers as a civilian. In that service, he took part in the survey and construction of several navigation locks and dams on the Kentucky river and was engaged in the maintenance of those facilities until 1911, when he joined the National Contract Company of Evansville, Ind., serving successively as assistant superintendent, superintendent and managing partner until 1925. When that concern turned to other industrial fields Mr. Maxon joined the United Engineers & Constructors of Philadelphia, doing the same kind of work for three more years before forming his own company with headquarters in Dayton. This nonmember recipient of the 1954 Moles award is active in Chamber of Commerce work in all its phases, in the Engineers Club in Dayton, and has been president of the Associated General Contractors since 1950.

Air-Sprayed Material Protects Building Walls

A NEW, textured surfacing compound for exterior walls is available for maintaining and protecting commercial or residential structures. Tradenamed Re-Nu-It, the asbestos-and-mica material is sprayed on with an air gun. It may be applied satisfactorily to wood, clapboard, masonry or to composition-shingle surfaces to a thickness of about 1/16 inch, or the equivalent of approximately ten coats of paint. When properly put on, it is guaranteed for ten years against chipping or cracking. Tests have shown that it makes a suitable covering because it allows water vapor to pass freely, yet is impervious to water. It is available in eleven colors, some of them pastel shades, and closely akin to stucco in texture and appearance.

Equipment required for application (which is usually done by an authorized local contractor) includes a compressor of at least 30-cfm capacity, an air-operated positive-displacement material pump, a spray gun of the internal-mix type with a 1/4-inch orifice, and two hoses. The air line is of 1/2-inch size and standard construction; the 3/4-inch hose that delivers the compound has a bursting strength of 800 psi. Interposed in the material line is a steady-flow valve to prevent spattering should slugs of compound pass through the gun.

In operation, the pump is mounted on the barrel in which the material is supplied. Actual spraying is much like applying paint, and, similarly, the surface must be free of grease and dirt to insure proper bonding. Spatter spots on surfaces that are not to be coated may be removed with a solvent within 24 hours. After that period the Re-Nu-It has permanently set and is no longer affected by the solvent.

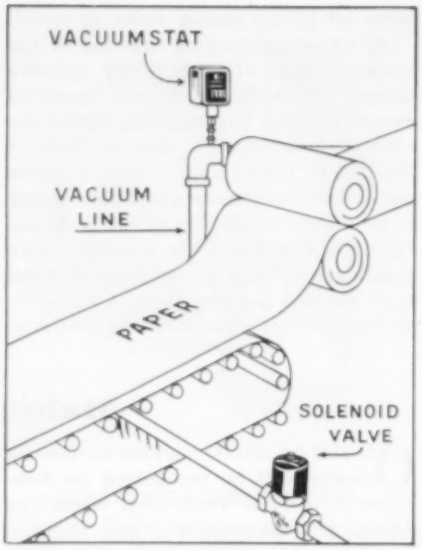


HOW IT IS APPLIED

The Re-Nu-It process being demonstrated at a building-trades show. The Ingersoll-Rand compressor pictured is powered by a 9-hp Wisconsin gasoline engine and delivers 37.5 cfm of air at 80 psi. The pneumatically operated material pump mounted on the shipping drum develops a pressure about 4 1/2 times that of the air. Because air for the spray gun is taken from a manifold on the pump only one air line from the compressor is required.

Pressure Drop Spots Break

THERE are many cases where valves, switches and other control equipment are actuated by a pressure differential in an air or gas system, particularly if they are of the positive-pressure type. Such applications, however, are less frequent in vacuum systems, and it may therefore be of interest to learn of one that has made it possible for the papermaking industry to solve a very troublesome problem.



On Fourdrinier machines, paper is formed on a fast-moving endless belt of fine metal mesh called the wire. As the latter moves along from the wet end of the machine, where the pulp is applied, some of the water is removed by drainage and some by passing the web through perforated suction rolls. By the time the wire has traveled its full length, the stock has been converted into a self-supporting sheet that can be transferred to the dry end, consisting of more press rolls and a series of heated cylinders where the remainder of the moisture is extracted.

When, as sometimes happens, the web breaks as it leaves the wire, it sticks to the latter and is carried back to the starting point, where more pulp is added. The result is paper of varying thickness unfit for use. To prevent this unevenness, it is the practice to direct a spray of water against the returning wire to remove the excess stock, an expensive procedure because the water flows continuously.

Recently, the instrument engineer of a western paper mill has devised a method by which the shower is turned on only when it is needed. He has installed a Honeywell Vacuumstat in the suction line on the first press rolls. Now, when a break occurs, the vacuum in the latter drops suddenly and causes the controller to actuate a solenoid valve which, in turn, operates the spray. The Vacuumstat is said to function so fast that the water is applied full force the instant the web tears and continues its cleaning action until the prescribed vacuum is restored and the sheet of paper feeds properly from the wire.

Editorials

ENGINEERING EDUCATION

WITH technology now at its zenith, it is difficult to realize that engineering education in the United States is little more than 100 years old. There was, in fact, but one state university—the University of Michigan—teaching engineering in 1853, and the course was of but two years' duration and conducted by the "Literary College" for the first 42 years.

This arrangement was made not only because it took time to enlist enough students to warrant a separate college and to develop a 4-year study schedule but also because those in charge were fearful that the instruction might become too technical and thereby deprive the students of the values to be found in a broad education. It may be observed in passing that their fears were perhaps well grounded.

Nowadays it is commonplace for engineers to rise to high industrial executive positions, and one of them, Herbert Hoover, attained the highest office in the country. Even those of the profession that do not become executives must most likely write readable reports with some regularity and may even be called upon occasionally to give a paper before a technical society or address a civic organization, service club or church group. A fair knowledge of the English language and of the arts and sciences makes such tasks easier to contemplate and execute and the literary productions definitely more digestible by the readers or hearers.

In line with such reasoning, and despite the fact that the first engineering societies were just coming into existence and the luncheon-club idea was more than half a century in the offing, one of the required subjects for budding Michigan engineers was "Aids to English Composition." By 1895, when the department of engineering attained the rank of a separate college, English instruction had expanded to two classes in "paragraph writing." French and German were also prominent in the early curriculum, but were deëmphasized in 1895. They were not discontinued, however, until 1931.

Founding and conducting the engineering course at Michigan were difficult. At first there was but one faculty member, Alexander Winchell, and he had a hard time even getting to Ann Arbor to take up his duties. He had been teaching in Alabama, and transportation facilities from there to Michigan were a little crude. As he progressed northward, weather conditions became steadily worse, but eventually he arrived, on January 14, 1853, and set about arranging a schedule for the few students who awaited him.

Textbooks were so scarce that Winchell had to resort largely to lectures in some subjects. Considering that he had received no engineering education himself and was then only six years out of Wesleyan University, the obstacles he had to overcome can be appreciated. By 1855 he had written enough instruction material for a book. Civil engineering was the first branch taught. Surveying was a vital subject, but the class could not be started until Winchell went to New York in May to obtain the necessary instruments. In the summer of 1855 he made a survey for a projected railroad from Ann Arbor to Jonesville and was paid the munificent sum of $5 a day for fourteen days. Of this experience he wrote: "The business is hard and responsible, but not unpleasant."

In those early years the one-man faculty taught all the engineering subjects and even filled in elsewhere in the university. Classrooms were heated by wood stoves, which were stoked by the professor or an obliging student. The water supply was a bucket and dipper.

Winchell transferred to the less demanding chair of geology and natural history in 1855 and was succeeded for two years by Lt. William Guy Peck, a graduate of the U. S. Military Academy at West Point, the nation's first school to institute engineering instruction. Peck went to Columbia University in 1857, but DeVolson Wood, who later did much to promote the school, fortunately came along to take his place.

Young Wood had just been graduated from Rensselaer Polytechnic Institute in Troy, N. Y., and immediately set out for Ann Arbor, where he had heard there was a teaching vacancy. He ran out of money at Detroit and walked the rest of the way. Hired to serve only until an older man could be procured, he filled the post so capably that he stayed on until 1872, when he took a similar position in Stevens Institute of Technology.

The original school of civil engineering at Michigan has now grown to twelve schools and there are several other branches of engineering that are not taught there. Truly, technology is becoming highly specialized. For many years, Michigan students took engineering in their junior and senior years only, first getting a foundation in the liberal arts. However, 95 years ago, Professor Wood suggested that it was time to think about making engineering a full 4-year course requiring at least one year of preliminary instruction in a college of liberal arts. Medical and law courses have long since been molded along those lines and are now almost universally set up as 7-year curriculums. So far, students fresh out of high school have been permitted to enroll in engineering colleges, but the day will surely come when they, too, will be obliged to acquire a broader education than they now receive.

Of necessity, this new order will have to wait until the demand for the slide-rule virtuosos slackens. At present, hordes of talent seekers from big industrial concerns, emulating big-league baseball scouts, invade the campuses months before commencement time with juicy contracts in their pockets ready to be signed. The prospective employers can hardly wait four years for the graduates, and certainly would turn all sorts of emotional handsprings if the mills turning out engineers adopted a 7-year production schedule.

WORKER OUTPUT

THE average American factory worker produces nearly three times as much as one in western Europe, according to a study made in twelve nations by the Stanford Research Institute acting for the U. S. Army's Operations Research Office. The figures, which are for 1950 and relate to industries that make or change goods in some way to add to their value, indicate that worker productivity is lowest in Spain—about one-seventh that of the United States. In Italy, it is one-fifth; in Sweden and the United Kingdom approximately one-half; and in Canada it is four-fifths. In Germany it was 32 percent in 1950, compared with only 15 percent in 1947, evidence that industry there is steadily becoming better organized. In all the countries, including the United States, it is growing at a rate of about 2 to 3 percent annually. Wages are generally in line with worker productivity, which means that the typical American gets about three times as much as his European counterpart.

Reasons for the variation in unit output are not well-defined. That the differences are not attributable to either greater mechanization or greater capital in this country is proved by the fact that, even when the factories compared have essentially the same equipment, the one abroad will be found to employ two or three times as many persons to get the same results. Differences in management background and philosophy apparently have some effect. It is said that European executives are apt to have a financial background; here they are more often trained in production or sales. The higher living standards of American labor also are believed to have a bearing on the matter, although it is difficult to determine whether our higher productivity is a cause or an effect. It seems, according to the report, that "the whole system and philosophy of American management and labor alike are responsible."

This and That

Leaks Prove Costly

Leaks cost the country two billion dollars annually, according to C. A. Benoit, Jr., head of the Permatex Company, Inc., which makes sealants for pipe lines and containers. These wasted dollars dribble out through faulty mechanical connections, gaskets and ruptures in air, water, gas, oil and vapor tanks, fixtures and pipes. Preventing or reducing this leakage adds up to one of the costliest maintenance jobs carried out by industries and consumers.

★ ★ ★

Mixing Business and Fun

David Trumball, a San Jose, Calif., salesman for A. G. Pond Company, spends some of his leisure watching "hard-top" automobile races sponsored by the California Racing Association. Among other things, he sells Ingersoll-Rand Impactools. At a recent race he noticed that each driver lost an average of two laps every time he had to stop to change a tire. When he prevailed upon Ray Raineri, one of the top pilots, to try a 4U Impactool, Raineri shifted tires while his competitors were making only half a lap, and that enabled him to go on and win the race by one lap. The speedy operation of the tool in running retaining nuts on and off the wheel capscrews brought him $800 in prize money. The first thing he did was to spend part of it for the Impactool.

Salesman Trumball got another driver to buy one of the tools as a result of the wager. The small automobiles carry only 8 gallons of gasoline and have to stop to replenish their supply one or more times during a race. Trumball bet the driver he could change a tire while the car was being refueled. He won the bet and made a sale.

★ ★ ★

Video Catches Thieves

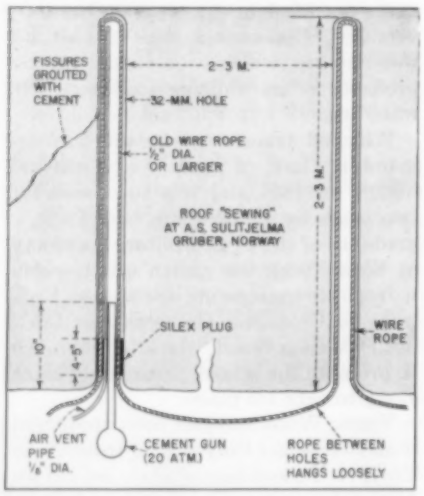
Industrial television apparatus, described in our May, 1953, issue, is being put to some novel uses that we did not mention. It is patrolling and guarding industrial and residential properties, transmitting fingerprints and signatures and, in a recent case reported from Hollywood, Calif., caught some thieves red-handed. Strangely enough, television equipment was the loot. It was disappearing from a branch outlet of the Radio Corporation of America, and ordinary detection methods failed to reveal the culprits. A television camera was hidden in the stock-room rafters with the lens focused on the loading platform. The receiver and viewing screen were located on the second floor. Police watching there saw a clerk place boxes of TV tubes on the platform one lunch hour when few people were about. Before long a pick-up truck backed into the driveway and put them aboard. Arrests and convictions followed.

★ ★ ★

Sewing Mine Roof

The accompanying diagram shows a method of roof support that has been successfully used for seven years in the A. S. Sulitjelma Gruber iron mine in Norway. It is a variation of roof bolting that is resorted to where the overlying rock is so unstable that bolting is considered inadequate.

As reported by *Engineering & Mining Journal*, the work is done as follows: Holes 32 millimeters in diameter and 2 to 3 meters deep are drilled 2 to 3 meters



apart and ½-inch wire rope is pushed to the top of each hole, forming a loop as shown. The wire is then carried to the adjoining hole. Between holes it hangs loosely and performs no function, but is left because that is cheaper than cutting it off. The pattern resembles stitching, which accounts for the name of roof sewing the miners have given it.

After that, a ⅛-inch pipe is shoved clear to the top of each hole; a piece of ¾-inch pipe about 10 inches long and having a connection for a cement gun at its lower end is partly inserted into the hole; and a Silex plug is put in place. The plug extends 4 or 5 inches into the hole and hardens in a few minutes so as to hold the two pipes and looped rope securely. Next, cement grout is introduced through the ¾-inch pipe with air supplied by a hand pump. The pressure is gradually increased to around 300 psi, which suffices to force the grout out into the fissures and cracks in the surrounding rock. Displaced air is ejected from the hole through the ⅛-inch pipe.

When the hole has been filled and will take no more grout, the operation is completed. The method is effective because it consolidates the loose rock, which is thus suspended by means of the wire rope from the solid rock above the zone of fragmented material. Einar Troften, chief engineer at the mine, devised the roof-sewing scheme.

★ ★ ★

Smuggler Founded Industry

A radio broadcaster in Edmonton, Canada, recently ascribed the beginning of the coal industry in the Province of Alberta to a whiskey smuggler in Montana, across the border. It happened back in 1872 when a youth named Nicholas Sheran, who had served as a drummer in the Union Army, made his way west to Fort Benton, Mont., 15 miles west of Great Falls and then a thriving community. Somehow he got started hauling illicit liquor across the border into Canada, where Indians were his principal customers. After making a few trips, he realized that there was no profit in going back with an empty wagon and, like truckers of today, began looking around for a return cargo. About the only thing available was coal, which outcropped along the Saskatchewan River and was being mined by the settlers in small quantities for their own use. Sheran either dug a load on each run or got somebody to do it for him. He found a ready market for the fuel 200 miles away in Montana, and two years later had a fleet of wagons in the business.

★ ★ ★

Mine 64 Years Old Closes

The Morning Mine, at Mullan, Idaho, a steady producer since 1889 and reputed to be the world's deepest source of lead, has closed down permanently. A few days before the shutdown date, a notice posted at the property informed employees of the impending action and explained that it was being enforced by "increased cost of labor and supplies, diminishing ore reserves and low metal prices." The step was not wholly surprising because the owner, Federal Mining & Smelting Company, since merged with American Smelting & Refining Company, reported in 1950 that known reserves were sufficient for only three more years of operation. In fact, the shrinking ore supply had been threatening the mine's existence for 30 years. In 1952, the property produced 83,104 tons of ore worth $3,152,454, but lost $104,995. Except for a salvage crew, that will pull out all equipment that is salable or usable elsewhere, the 275 employees have been laid off and the workings will be allowed to fill with water.

Industrial Notes

Under the name of Speedset, the Waco Manufacturing Company is offering a new adjusting collar for its steel shore available in 6-, 8- and 10.6-foot lengths that may be extended an additional 5 feet. The device has four lateral grooves spaced 1 inch apart and enables a shore

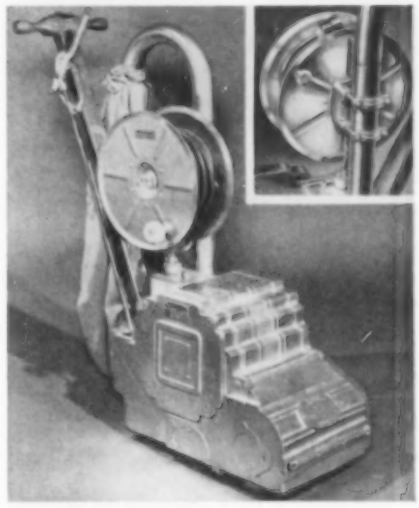
to be set not more than one inch from the desired height. Rapid adjustment is a feature, say Waco officials, for less than four turns of a screw handle suffice to put a shore in place with a snug fit. Nailing plates serve as bracing, and flat-plate 8- and 14-inch J-heads are supplied to meet different shoring requirements.

Friction losses attributable to wear and tear are reduced, it is claimed, by a compound of copper and lead alloys called Cop-Sil-Loy. Developed primarily as a friction stabilizer for regular brake linings, it is now offered for use on overhead cranes, forging hammers, V-belt sheaves, punch presses, conveyor-belt systems, etc. According to the producer, Cop-Sil-Loy Incorporated, the material increases the total contact area by filling in pits and pores in drum and lining surfaces of braking parts of machines; sustains friction at temperatures up to 900°F (melting point 1250°); serves as a lubricant; dissipates heat rapidly; and does not deteriorate.

A substitute for hot-dip galvanizing that is said to possess most of its advantages and none of its disadvantages has been announced by Corrosion Limited of London, England. It's a cold process by which a viscous fluid composed of zinc dust, plastic resin binders and solvents is applied by brushing or air spray. The manufacturer claims that the liquid, called Glopane, gives the same electrochemical protection as metallic zinc. If the coating is scratched down to the base metal, an electrochemical cell is set up in the presence of moisture. In that case the iron or steel is the cathode and is not attacked, while the zinc is the anode and is sacrificed. Cracks or pinholes may therefore be the cause of local corrosion, but electrochemical reaction will prevent the spread of rust beneath the surface metal. When one gallon is used to cover 500-600 square feet, the coating will contain about ¾ ounce of zinc per square foot of surface. The company has also developed Glopane Wet for application to wet iron or steel, and even to submerged surfaces.

Hazardous flame failure of gas, oil or combination gas/oil industrial burners is preventable by use of a new Fireye Programming Control, according to Combustion Control Corporation which developed the "package unit." Automatic in its action from startup to shutdown, it depends for its effectiveness on a flame-sensitive Firetron cell that is said to cut off the fuel supply in two to four seconds after a burner is accidentally extinguished.

Port-O-Reel, recently developed by Industrial Electrical Works, is one answer to the problem of long electric cords for portable power equipment. It is provided with a mounting bracket, a built-in dust-tight collector ring that permits continuous flow of current as the reel is turned and an adjustable brake and lock. Units will hold up to 150 feet of 16-2 conductor cord. The manufacturer claims that the reel is ideal for mobile power equipment such as industrial vacuum cleaners, floor sanders, grinders, bench saws, lawn mowers, conveyors and sprayers using up to No. 12 three-conductor cord.



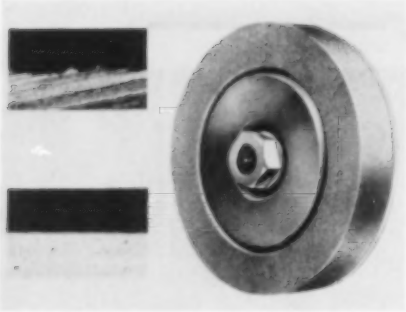
NO TANGLING AND KINKING

This picture shows a Port-O-Reel mounted by means of a bracket (see insert) on the frame of a floor-sanding machine. Exclusive of cord and plug, the unit weighs approximately 5 pounds.

A new sharpening method for carbide cutting tools developed by Penn Scientific Products Company involves the use of a dual grinding wheel consisting of a vitrified-bond outer wheel of 120-grit silicon-carbide for dry-finish grinding and of a phenolic resin-diamond insert for diamond lapping. The latter operation is said to reduce the surface finish

MORE AIR POWER FOR TIE TAMPER

The McWilliams Multiple-Tool Air Tamper for railroad maintenance is now available equipped with a 600-cfm Ingersoll-Rand Gyro-Flo compressor instead of a 315-cfm unit. Tests have shown that the additional air capacity makes it possible to increase the tamping rate approximately 40 percent. When raising track 4 to 5 inches and using 2½-inch stone ballast under 24 ties to the 39-foot rail, a tamping rate of 585 feet of track per hour was recently obtained over a 5-day period. The speed at times reached 620 feet per hour.



DUAL GRINDING WHEEL

At the right is the Pensco wheel with the phenolic resin-diamond lap insert. The microphotographs show (top) a finish grind surface produced by a 120-grit diamond wheel and (bottom) the diamond lap finish obtained by means of the new sharpening method.

of the cutting edge from 15 to 20 rms (after finish grinding) to 1 to 2 rms. Tests under service conditions have proved that tools sharpened by this method last from three to eight times longer than they do when the more expensive diamond wheels are utilized. The Pensco Dual Wheel is suitable for use on tool grinders and comes packed in a kit including a 5-gram tube of Spectrum Diamond Lapping Compound in any one of twelve standard grit sizes and a 4-ounce bottle of diamond lapping oil with atomizer applicator.

A self-focusing, nondistorting rectangular magnifying instrument that can be placed on reading material and moved as desired is offered in 3-, 6- and 9-inch sizes by J. B. Sebrell Corporation as an aid to all those who need visual help in their daily work or reading. The 9-inch glass fits holders of copy material frequently used by typists.

J. N. Fauver Company, Inc., has announced a fixture that is designed to test four tube assemblies at one time.

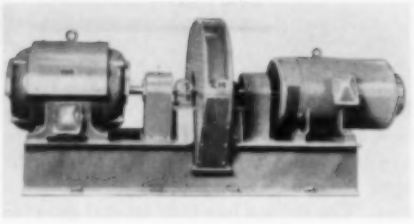
The operating cycle involves clamping the assemblies in position, lowering the fixture into a tank of water and admitting air under 80 to 100 psi pressure into each tube. If faulty, the air will escape and indicate any leak by bubbles rising surfaceward. The equipment includes a stand, the tank, an air filter and a regulator.

Horizontal and vertical aluminum-alloy tanks ranging in capacity from 5800 to 16,400 gallons are being constructed by Aluminum Company of America for the storage of liquids under atmospheric or low pressure. They are 10 feet in diameter and provided with a manhole of the swing or fixed type, the latter for use where pressure is involved.

Hannifin Corporation has added two pressure-operated, solenoid, poppet-type 4-way air-cylinder control valves to its P-M (Pilot Master) line. They are recommended for speeds up to 600 cycles per minute and are designed for such

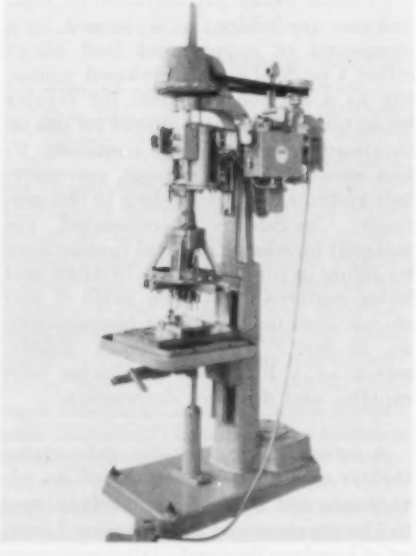
operations as controlling switching mechanisms for conveyors, welder cylinders, and clamping and work-positioning cylinders on various automatic and semi-automatic machines. Similar valves are available in larger sizes. The latest models are for use on ¼-inch air lines. One of them has a single solenoid and is spring-returned; the other is provided with two solenoids.

Flywheel motor generator sets with emergency transfer control have been announced by Electric Machinery Manufacturing Company and are said to insure continuous power for microwave equipment used for protective relaying, supervisory control and communication along utility, pipe and similar long distance systems. Under ordinary conditions, the set operates from a commercial line, but during power interruption the energy stored in the flywheel drives the generator to furnish current with a frequency tolerance down to 50 cycles for a 7-second interval. This suffices to start, automatically, an emergency standby generator set and to switch the microwave equipment from the flywheel to the emergency power source. When the standby power voltage and frequency are normal, a mechanically interlocked throwover switch connects the micro-



wave system to the emergency unit. The equipment is automatically transferred back to the motor generator set when commercial power is restored.

Beckett-Harcum Company, Inc., has begun the manufacture of a line of heavy-duty drilling and tapping machines with electrically controlled air-powered thrust. Two models are available: C-16 intended for drilling, and C-16-T for drilling and single and multiple tapping in a wide range of sizes. Precise control of the air thrust at low pressures is said to insure extremely sensitive tapping action which permits the tap to provide its own lead and thus reproduce a thread with maximum fidelity to the ground tap. Once the tap has entered the work, the only force exerted on it is rotary torque. When the predetermined depth of stroke is reached the spindle starts to ascend the instant the motor reverses, and the tap leads out without stripping the last thread even in extruded holes in soft materials such as plastics and magnesium. Drilling operations can be performed by cutting off the motor reversing controls, and the same fixture may be used for tapping by removing the drill bushings. Both models are equipped with



FLOOR MODEL

Bench-type machines with two, three or four heads are available, and all models have a maximum thrust of 980 pounds at 100 psi. The picture shows the C-16-T which is designed for both drilling and tapping. It has a sliding head and an adjustable worktable.

dual air-cylinder transmission which makes for fast approach, correct feed and maximum cutting efficiency. Approach and return speed and working thrust are widely variable. Precision limit switches and an instant-acting Hi-Cyclic balanced air valve assure reliable depth control.

A suspension-type, 4-way air manifold that permits a group of operators of

pneumatic tools to work at a bench without danger of interference has been designed by Lynco Inc., and is being distributed by Burklyn Company. The unit, complete with moisture trap and drain, is light in weight and may be used with either straight screw-in connections or Foster quick-detachable hose fittings. The air inlet has a ¾-inch pipe thread and each of the outlets a ¼-inch thread.

QUOTES

—FROM HERE AND THERE

Still Growing

"The air power revolution in the air compressor industry has nothing to do with jet or atomic airplanes; its revolution is the tremendous development of compressed-air powered tools which is blowing up compressor sales to record levels.

"Sales in the air and gas compressor industry totaled $214 million last year, and the former accounted for the bigger slice. Most air compressor manufacturers report that 1953's volume will hit a new high . . . . Predictions for 1954 are equally optimistic."

Steel Magazine, October 26

Air Muscles

"Properly compressed and coupled to this drilling tool (a rock drill was illustrated), air packs a rock-busting wallop. How different from the days when men swung sledges, and even cracking pavements was a slow, tortuous task . . . as were many other manual tasks in industry.

"When men of science learned how to put a cyclone in a cylinder, pneumatic tools and compressed air became salient servants in saving men's muscles and industry's time.

"In its more than 200 applications compressed air cleans, sprays, operates machines for hoisting, hauling, hammering, drilling, cutting, grinding, blowing, pumping. Applied in free or enclosed action, this versatile, conveniently conveyable power agent may be found at work in mines and mills, on highways and skyways, on and under the water, in production and processing."

From an advertisement by McGraw-Hill Publishing Company

Inflated Forms

"Blimp-like balloons of rubber-coated fabric are being put to work by Goodyear in heavy concrete construction. Pumped full of air, they serve as forms over which concrete is applied. After the concrete has set, the air is released and the collapsed balloon withdrawn through an opening. For the construction of igloo-like grain-storage sheds and farm utility buildings, and for military purposes, the method is fast and cheap because it eliminates the need for framework."

Reader's Digest

RAPID SHIFTING CRESCENT SCRAPER SUPPLIES 2000 TONS OF FILL PER DAY

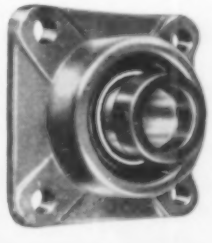
Above is a typical example of how a Sauerman scraper simplifies a dig-and-haul job. A 400-ft. span machine, powered by a 150-hp. motor, backfills an empty stope at a large nickel mine in Canada. Operated by one man, this scaper scoops gravel and clay from side of a hill and moves the material down to a "raise" at rate of 2,000 tons per day.

All kinds of long range material handling jobs are accomplished most economically by use of a Sauerman Drag Scraper. You find this versatile one-man machine digging material out of open pits, cutting down hills, strip mining, cleaning out sludge basins, storing and reclaiming coal, ore and other bulk materials. Wherever used, it saves time, money and manpower.

Sauerman builds scrapers in sizes from ½ to 15- cu. yds. Get complete details by writing for Sauerman Field Reports and Catalogs.

SAUERMAN BROS. Inc.

548 S. Clinton St., Chicago 7, Ill.



no service schedules needed for LIFE-LUBE bearing units

Wood's pre-lubricated Pillow Blocks and Flange units give you trouble-free operation *for life*. Scientifically designed to provide permanent lubrication . . . means no lubrication is necessary once they leave our factory.

Neoprene seal keeps grease in, foreign matter out. Install Life-Lube and tear-up bearing service schedules. Sizes from ½" to 2 15/16". Wood's bearings for all operating conditions are available through Industrial Distributors. Write for Bulletin 194.

T. B. Wood's SONS COMPANY

CHAMBERSBURG, PA.

Mechanical Power Transmission Manufacturers—Since 1857.

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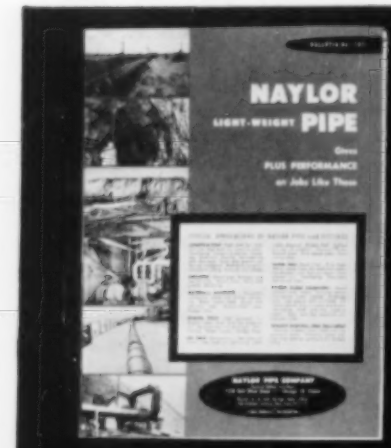
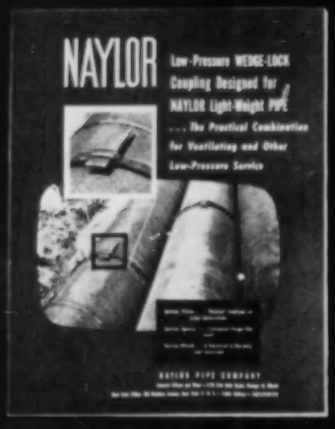
SHORT COURSE ON PIPING

These four bulletins make up a handy reference library on light-weight pipe, connections and fittings and their applications in your field.

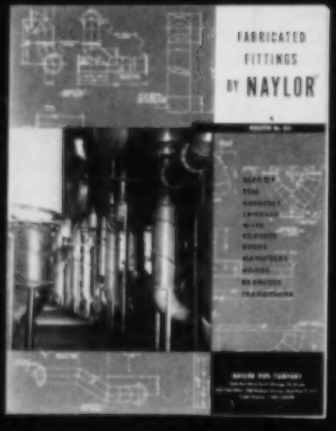


Bulletin No. 507 covers the applications and specifications of Naylor light-weight pipe and fittings.

Bulletin No. 513 presents data on Naylor heavy-duty Wedge-Lock couplings for permanent or temporary service.



Bulletin No. 514 offers information on Naylor low-pressure Wedge-Lock couplings for vent pipe.



Bulletin No. 525 deals with Naylor fabricated fittings for both standard and special requirements.

Copies of these bulletins are available on request.

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, New York

Books and Industrial Literature

Metal Machining by Lawrence E. Doyle, Associate Professor of Mechanical Engineering, University of Illinois, is original in its approach and was written to give the engineer or prospective engineer a comprehensive introduction to metal machining and process planning as well as an easy-to-grasp description of equipment, methods and techniques. Major machine tools and operations are discussed in logical sequence, beginning with a presentation of dimensions, tolerances and gauges. Cutting tools, lathes, and screw machines are also covered, and subsequent sections deal with shaping, planning, drilling, milling, boring, broaching, grinding, surface finishing and gear making. The author has had more than fifteen years of experience in his field. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price, $10.00.

Nickel Alloys in Railroad Equipment is the title of an illustrated publication that may be obtained by writing to The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

An illustrated brochure issued by Cleveland Broach, Inc., 1061 E. 260th Street, Cleveland 23, Ohio, describes its line of precision broach bars and fixtures for jet, automotive and allied industries.

A new booklet issued by Hewitt-Robins, Inc., Stamford, Conn., describes its new Style J Vibrex vibrating screen designed especially for use in small quarries, roadside contractors' plants, for makers of cinder blocks, etc. Ask for Bulletin No. 122-J when requesting a copy.

Compressed-air locomotives for underground service operating on an initial pressure of 100 psi are dealt with in Bulletin No. 18-a being distributed by Mayo Tunnel & Mine Equipment, Lancaster, Pa. Diesel locomotives, muck cars and car passers for similar use are also described.

C. B. Hunt & Son, Inc., Salem, Ohio, is offering free upon request a new condensed catalogue—No. 531—describing its Quick-As-Wink line of air and hydraulic control valves, valve couplings, etc. Sectional views of body, plunger and packing are shown, as well as interior operation.

The story of how furnace and induction brazing reduces costs, increases production and achieves higher quality is told in case-history style in Bulletin GEA-5889 offered by General Electric Company, Schenectady 5, N. Y. The 12-page booklet is the latest in the company's series on modern metal processing.

A leaflet containing information on Fischer steel balls and their applications may be obtained without charge from Frazar & Company, Inc., 50 Church Street, New York 7, N. Y., United States distributor for Kugelfischer Georg Schafer & Company, Schweinfurt, Germany, manufacturer of chrome-, stainless- and other steel balls.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., is offering readers two new publications: Form 4146 on its complete line of Carset Jackbits which serves as a guide in selecting the right one for a given connection and application, and Form 4126 on tools and accessories for paving breakers. The latter contains instructions on reforging and rehardening moil

and wedge points, chisels, etc. Both can be obtained from the company's head and branch offices.

Carlyle Rubber Company, Inc., 64 Park Place, New York 7, N. Y., offers a new catalogue covering most of its industrial hose assemblies made to order for machines and mechanical equipment. Line includes air, hydraulic, paint and lubricating hose connections. For a copy of Catalogue 3-1952 address the firm's Hose Assembly Manufacturing Division.

Preferred Utilities Manufacturing Corporation, 1860 Broadway, New York 23, N. Y., has published an 8-page booklet, No. 175-G, describing the design and structural features of its extended line of Model B and BR belt-driven, horizontal, rotary-type heavy-oil burners ranging in capacity from 12 to 175 gallons.

Features of Type H starters with air or oil contactors built to control squirrel-cage, synchronous, wound-rotor and multispeed motors in ratings from 2200 to 5000 volts are described in a 12-page booklet—Bulletin 14B6410B—lately released by Allis-Chalmers Manufacturing Company, 1000 S. 70th Street, Milwaukee, Wis.

Wagner Electric Corporation has published a leaflet, EU-106, No. 12, illustrating and describing its new line of 80°C rise Class B dry-type transformers. They are built in single-phase ratings from 3 to 100 kva, 600 volts, maximum, and are suitable for use where low voltages are required for machines, portable tools or lighting. For copies write to the company's Sales Promotion Department, Electrical Division, 6400 Plymouth Avenue, St. Louis 14, Mo.

Crush Truing is the title of Technical Bulletin No. 531 issued by Norton Company, Worcester, Mass., and written by Bruno D. Hendrickson, company grinding engineer. It presents engineering data on crush truing multirib wheels for thread grinding and on specially formed face wheels, a process industry has accepted widely in recent years. The purpose of the 15-page brochure is to answer questions that have been asked about the subject.

A revised catalogue, No. 801, released by F. J. Stokes Machine Company, 5500 Tabor Road, Philadelphia, Pa., deals with its line of single-punch and rotary tableting presses for compacting pharmaceuticals, powdered metals, plastic preforms, chemicals and catalysts, ceramics, carbide-tool tips, grinding wheels, etc. Free upon application, it describes each model in detail and lists its recommended uses.

Taylor Forge and Pipe Works, P. O. Box 485, Chicago 90, Ill., has announced the first issue of its new house organ that is designed to help those concerned with piping and pressure vessels. Contents includes keeping up to date on codes and standards, basis used by the codes for establishing allowable stresses, tables of maximum allowable stresses and a review of recent literature and standards. Vol. 1, No. 1 is free on request.

A new 8-page bulletin, Ad-147, dealing with many of the silicone-rubber products made by The Garlock Packing Company, Palmyra, N. Y., will be mailed to anyone interested upon request. Among the products illustrated are diaphragms, gasketing, sheet packing, oil seals, rings, insulation tape, rod and valve-stem packings and molded shapes for many industrial uses. In addition to applications, the booklet lists the special properties of silicone rubbers.

THE NEWEST, QUICKEST WAY TO MAKE ENDS MEET

the job's a snap...with a snap-joint

Here's the newest development in Mechanical Pipe Couplings—the Victaulic Snap-Joint *boltless toggle* pipe coupling.

The Snap-Joint extends the Victaulic Method into usages where speed and frequent dis-assembly and re-assembly are controlling factors. Snap-Joints assemble over the pipe ends in a matter of seconds with a speedy hand-lock . . . no wrenches required.

Snap-Joints, made to supplement Victaulic's famous line of bolted couplings, are ideal for temporary lines, valve, meter and pump connections and similar uses . . . their strength and durability make them completely reliable for permanent installations.

Snap-Joints fit Victaulic grooved pipe and the complete line of Victaulic Pipe Fittings . . . Ells, Tees, Reducers, Caps, etc. Every joint serves as a pipe union.

New Victaulic Snap-Joints are ready for your next job through all Victaulic Stocking Supply Houses. Available in pipe sizes: 1", 1¼", 2", 3" and 4". They are part of the world famous *complete* Victaulic Method of Piping.

Write today for Victaulic Snap-Joint Catalog No. 44-8B

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Office and Plant: 1100 Morris Ave., Union, N. J. • Telephone Elizabeth 4-2141
West Coast: Victaulic Inc., 2330 East 8th St., Los Angeles 21
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Export: Pipe Couplings, Inc., 30 Rockefeller Plaza, N. Y. 20, N. Y.

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EASY OPERATING
PLUG VALVE

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ROD PACKING RINGS

- **Preferred** for original equipment installations . . . preferred for replacement parts.
- **High quality,** precision construction to insure better performance and longer life.
- **Styles for any service,** for any operating temperature, for any gas condition.
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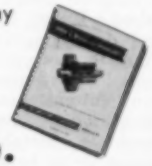
- **Prompt deliveries** of rings from stock for any standard compressor.
- **Engineering cooperation** always available.



WRITE FOR CATALOG NO. 440 AND FULL DETAILS

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INCORPORATED
Dept. 1, LOUISVILLE 3, KY.

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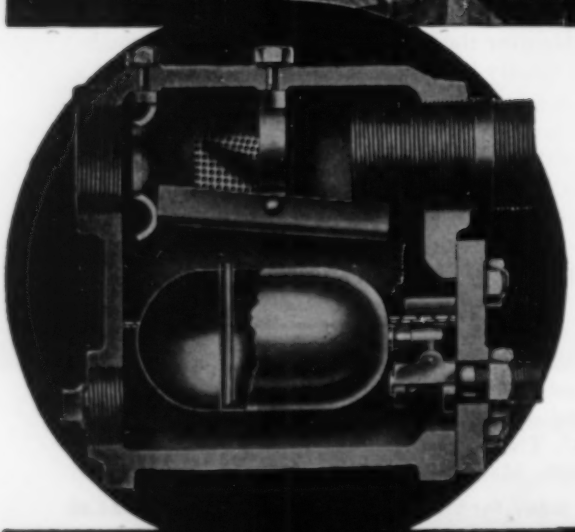
INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



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DRIAIR

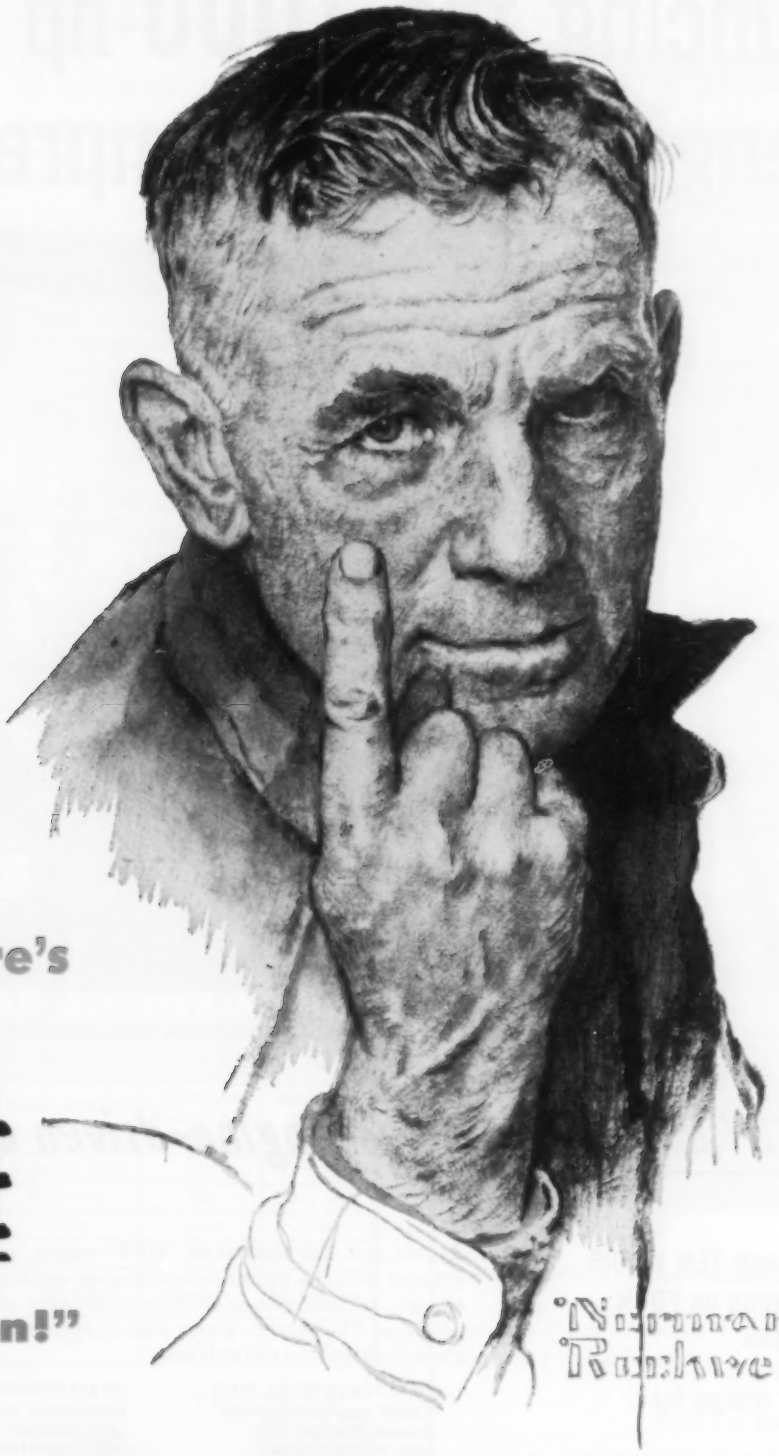
SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.
"SPECIALISTS IN COMPRESSED AIR DEVICES"
PLAINFIELD, NEW JERSEY



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For maximum wire rope efficiency and economy, call your nearest Roebling office for a Field Man. He'll recommend the best ropes for your machines.

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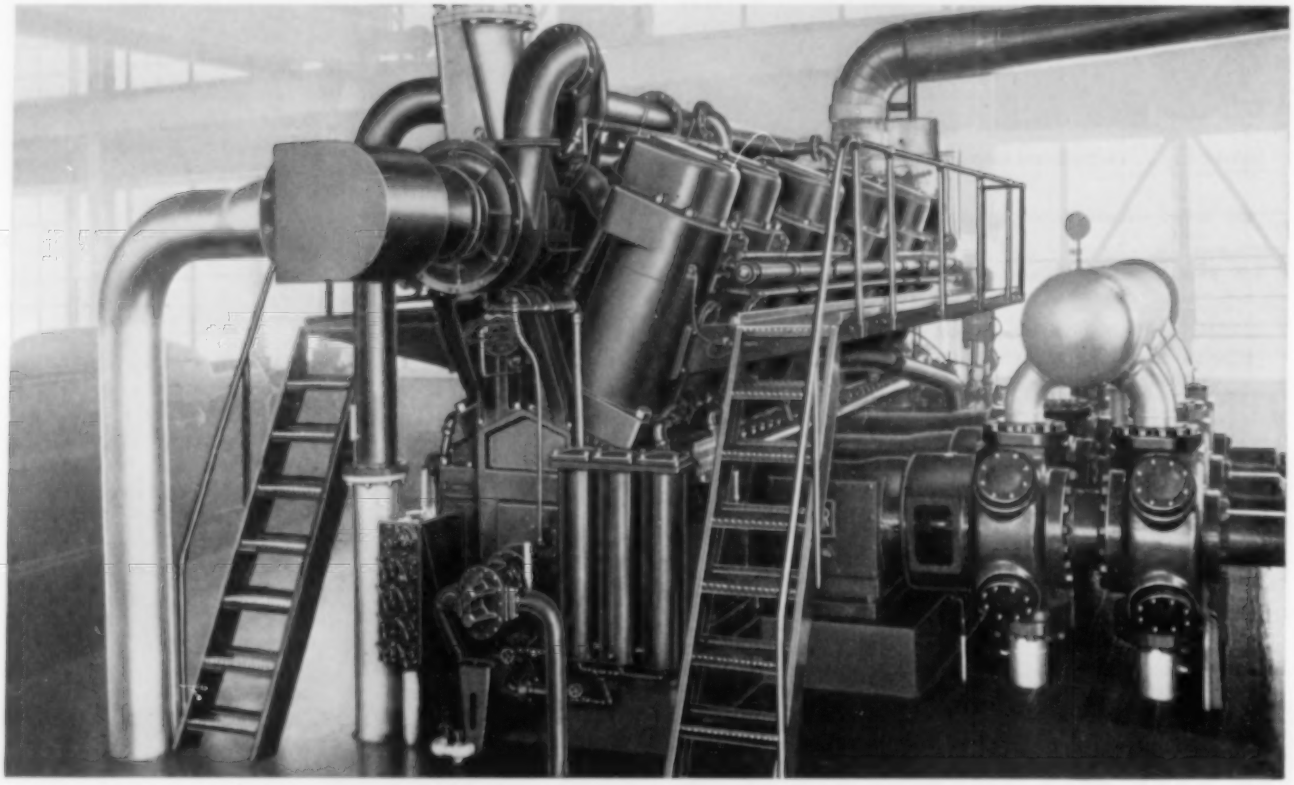
Announcing the 2000-hp KVS gas-engine-driven compressor



Here's the first installation of a TURBOCHARGED gas-engine-driven compressor. This Ingersoll-Rand KVS unit went on stream early in 1952. Its performance has lived up to every expectation.

The FIRST TURBOCHARGED gas-engine-driven compressor!

...developed through **TEN YEARS** of experimentation on **FOUR** full-sized engines

...shop and field tested for **THREE YEARS**

...service proved for more than a year

...now available in a regular production unit, the 2000-hp KVS

In the new TURBOCHARGED "KVS" engine, waste energy from the exhaust provides power for scavenging and supercharging, through two gas-turbine-driven centrifugal blowers, one at each end of the machine. The result – a new high in efficiency and economy! Note these outstanding advantages:

MORE POWER IN LESS SPACE	NO AIR COOLING
LOWER FUEL CONSUMPTION	ECONOMICAL COOLING SYSTEM
COOLER RUNNING	EASY STARTING
LOW HEAT REJECTION	FOUR COMPRESSION CYLINDERS

ULTRA CONSERVATIVE RATING

Features such as these make the new KVS an important advance in the design of Ingersoll-Rand's traditionally dependable V-angle, 4-cycle gas engine. Ask your I-R representative for the complete story.

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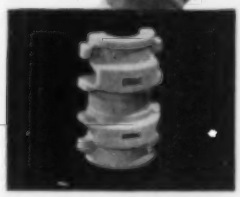
COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

BEARIUM METAL superiority proved in over 25 years of "on-the-job" service in scores of varied applications.

Wherever there is a bearing application involving high speeds, poor lubrication, heat-generating loads, elevated temperatures, dusty and gritty surroundings—or where a liquid other than oil is used as a lubricant—there you will find the ideal application for BEARIUM METAL. For it is under adverse operating conditions such as these that BEARIUM METAL out-performs all other types of bearing materials . . . by prolonging bearing life, preventing shaft seizure and scoring. In short, it does a more efficient job longer at lower operating cost.



Special castings made to customer's specifications.

We'll be glad to send you the complete story on BEARIUM METAL, so write TODAY!

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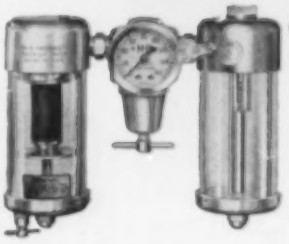
Prominent User Acclaims

"M-B" Automatic Air Line FILTER, REGULATOR and LUBRICATOR Assembly



"Your 'Sentinel of the Air Line' has been giving us very good service. We have had no complaints at all and I trust that we will be ordering more of them in the near future."

signed: A. E. Cranston, Sr.
PRESIDENT
Cranston Steel Strapping Co.
Oak Grove, Oregon

The value of "M-B" Automatic Air Line Filters, Regulators and Lubricators is widely known for their effectiveness as a protection to Air Valves, Cylinders, Pneumatic Tools, etc.

WRITE FOR LITERATURE

M·B PRODUCTS
46 Victor Ave.
DETROIT 3, MICHIGAN

HOW TO GET BETTER COMPRESSED AIR DRAINAGE!

USE THE RIGHT TYPE TRAP FOR THE JOB!

TYPE OF TRAP	SNAP ACTION (Fig. 1)	REGULAR BALL FLOAT (Fig. 2)	INVERTED BUCKET (Fig. 3)
Handles oil?	Light oil only	No	Very well
Handles dirt?	Moderate	No	Very well
Air loss?	None	None	Small
Requires priming?	No	No	Yes
Float collapse or leakage?	Remote	Remote	Impossible
Gravity drainage to trap required?	Yes	Yes	No

FIG. 1

FIG. 2

FIG. 3

GET THE FACTS:
FREE AIR TRAP BULLETIN *Send Today*

ARMSTRONG MACHINE WORKS
885 Maple Street, Three Rivers, Mich.

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Cameron Pump Operator's Data.....$2.00
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☐ Cameron Pump Operator's Data and Cameron Hydraulic Data. Both Books.....$4.50
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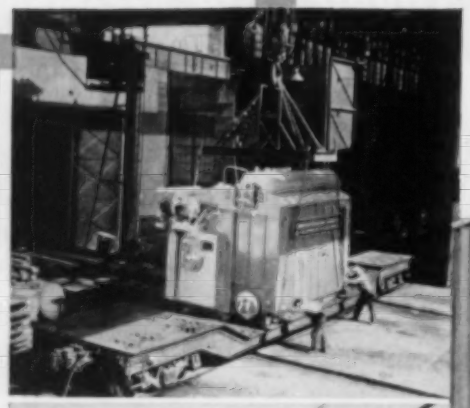
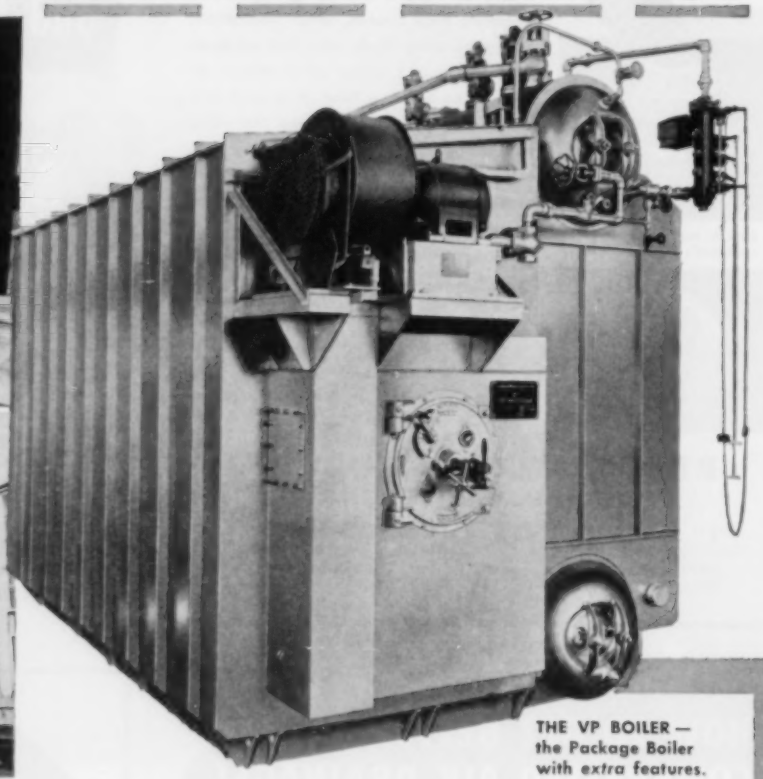
4 reasons why...

THE VP PACKAGE IS YOUR BEST BOILER BUY





THE VP BOILER — the Package Boiler with *extra* features.

1 Fully Water-Cooled Furnace — More cooling area per cubic foot of furnace volume than any other boiler of the VP's size and type. In all but the three smallest sizes, the VP Boiler has water-cooled walls on *all six sides* — including the burner wall. Assures rapid, efficient heat absorption. Minimizes furnace maintenance.

2 Larger Lower Drum — The 30 in. diameter lower drum permits a simple, symmetrical tube arrangement . . . provides easy access for washing down or inspection . . . its greater water storage capacity facilitates the handling of fluctuating loads.

3 Simple Baffle Arrangement — Minimum changes in direction — no baffle at all in convection bank in larger VP Boilers. This means lower draft loss . . . simplified soot blowing . . . elimination of dead pockets, thus, maximum heat pick-up. In the intermediate sizes, a water-cooled baffle assures minimum maintenance.

4 Centrifugal Fan — This more efficient type of fan operates at lower speed than other types and is quiet in operation. In fact, its average noise level is less than half that of typical high-speed blowers used in most package boilers.

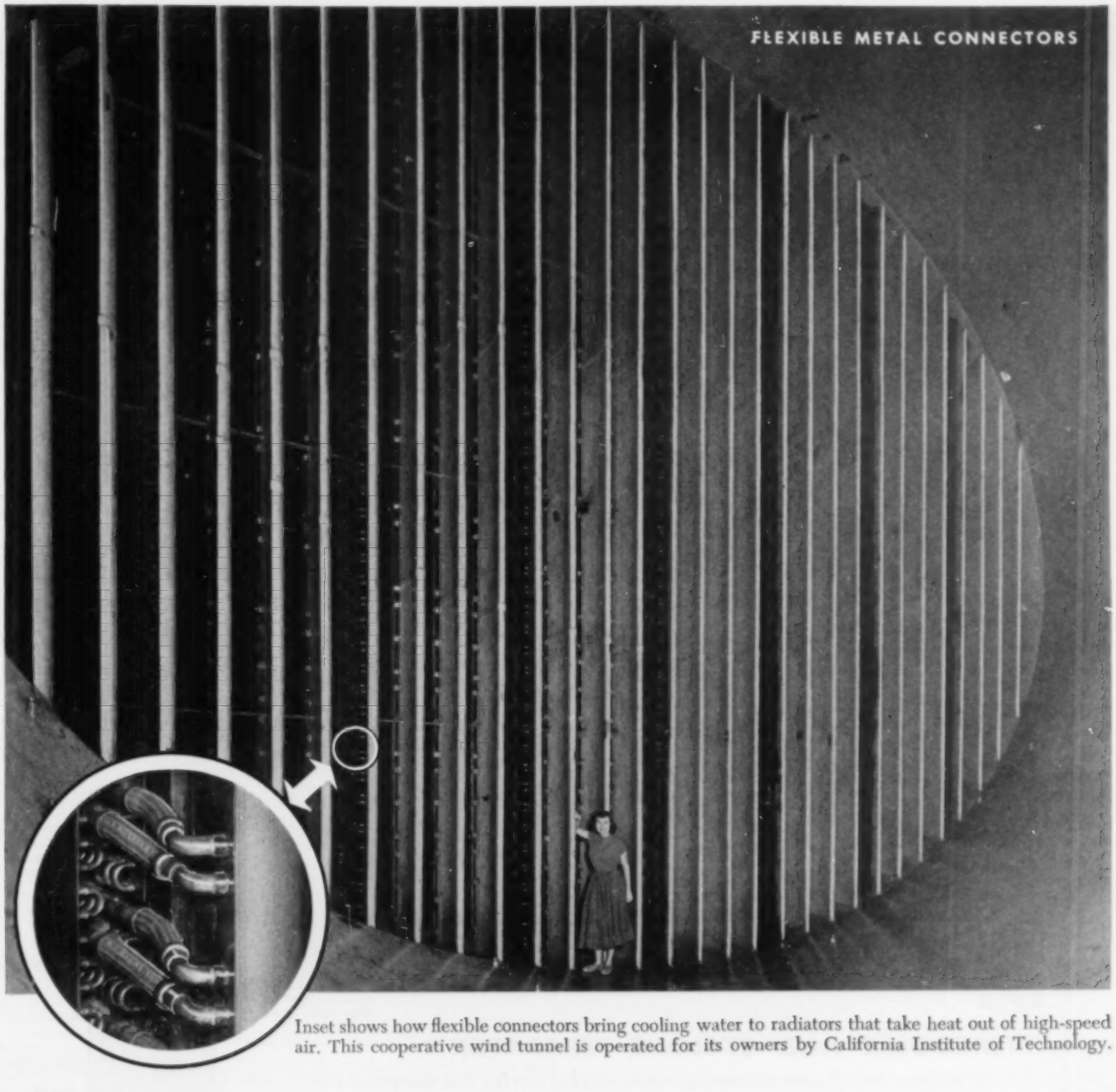
These four *extra* features are yours *only* in the VP Boiler which is designed and manufactured by Combustion — maker of many of the world's largest boilers. These units are available in capacities ranging from 4,000 to 30,000 lb of steam per hr, and pressures up to 250 psi.

Complete details on the C-E Package Boiler, Type VP, are available to you. Send for your free copy of Bulletin VP-**241.** B-6668

COMBUSTION ENGINEERING, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



Inset shows how flexible connectors bring cooling water to radiators that take heat out of high-speed air. This cooperative wind tunnel is operated for its owners by California Institute of Technology.

650 Connectors help put the chill on fast-as-sound air

In Pasadena, Calif., five aircraft manufacturers jointly own this giant wind tunnel. There they test designs at air speeds as high as sound itself.

But, when you squeeze air to get such jet-age speeds, you also heat it up. So you look for a way to cool it off. Here they used a solid bank of finned cooling coils; but then they had to get cooling water to them through 650 piping connections. First, they had to consider aligning each opening; then expansion when temperatures rose and fell. And they had to keep the airstream bone dry. No leaks allowed.

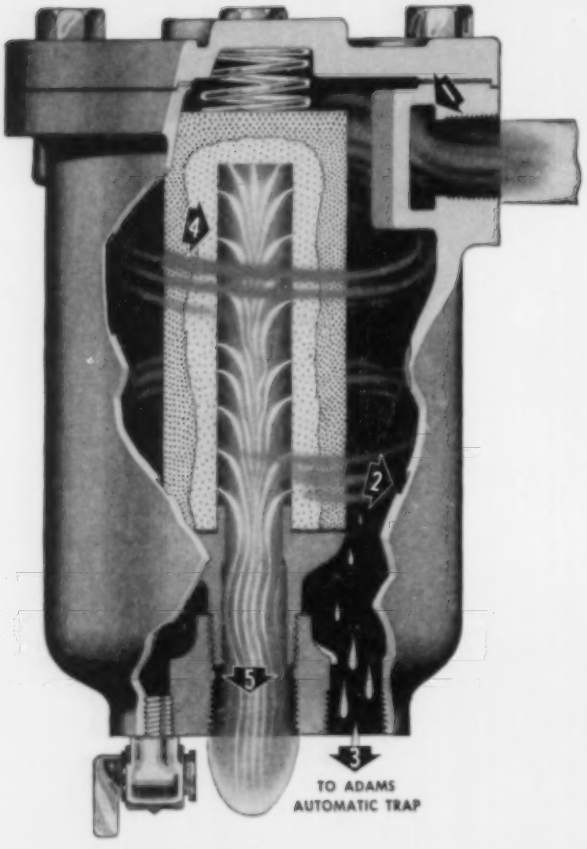
They did it the easy way . . . with American Seamless Flexible Metal Connectors known as Vibration Eliminators. They had no trouble installing them. A solder-type connection made them permanently tight.

Maybe there's an idea here for you. American Flexible Metal Hose and Tubing have many uses . . . for connections that must move, bend, vibrate, connect misaligned ports . . . or piping in cramped spaces. They can safely carry almost any liquid, gas, chemical or semisolid. And you can get them in many alloys, sizes and types. Write for Catalog SS-50 to *The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Co., Ltd.*

53242

wherever connectors must move... ANACONDA *American* flexible metal hose and tubing

ADAMS *has both* *



—— BOTH ANSWERS TO THE PROBLEM OF KEEPING WATER, WATER VAPOR, OIL AND DIRT OUT OF COMPRESSED AIR LINES

There's no *one* answer to this problem! The most expensive aftercooler you can buy will not remove scale that is picked up in the distribution lines. The most expensive air filter you can buy cannot guarantee removal of water vapor until it has been condensed by cooling. That's why Adams makes both.

* PORO-STONE *AIR FILTER*

1. Centrifugal separation of dirt and liquids.
2. Drainage to trap directed by vertical cast-in slots.
3. Continuous, fully automatic trap action.
4. Rapid diffusion and filtration through permanent, cleanable Poro-Stone.
5. Clean, dry air at practically unchanged pressure. Standard, stocked sizes handle from 10 to 700 cfm.

Easily installed in either vertical or horizontal pipe line.

* *AFTERCOOLER AND CYCLONE SEPARATOR*

Cools air to within a few degrees of cooling water, making certain that compressed air is colder than surrounding atmosphere, so that no further condensation can take place.

Counter flow, air-through-tube design assures continuously high heat transfer rate.

Double cyclonic action deposits all water and entrained oil in moisture chamber.

R. P. ADAMS CO., INC.
209 E. Park Drive, Buffalo 17, New York

Please send me your latest literature, Bulletin No. 177 on BOTH the Poro-Stone air filter and the Adams Aftercooler — Cyclone Separator.

Name .....

Company ..... *Title* .....

Address .....

City ..... *State* .....

FOR YOUR PROFIT'S SAKE
— FIND OUT ABOUT BOTH

R. P. ADAMS CO., INC., BUFFALO 17, N. Y.

WHERE EXPLOSIVES RESEARCH PAYS OFF

To blast 305,000,000 tons of stone and nonmetal materials for America's ever-growing construction, road building, and steel industries requires more than 166,000,000 pounds of dynamite annually. Here, as illustrated above, is where explosives research pays off. Note the excellent fragmentation which minimizes secondary blasting . . . the low stone pile which increases and speeds up the production of the shovels.

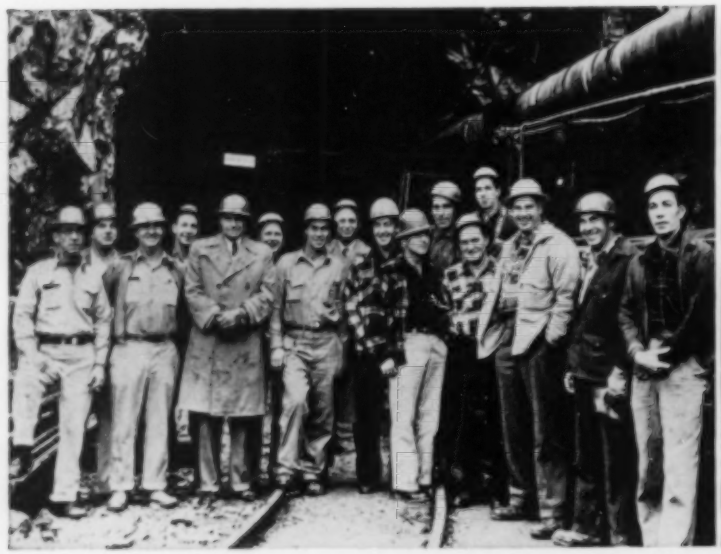
Such results come not only from specially developed explosives and blasting supplies, but also by using the most modern blasting methods. Hercules' continuous research and extensive knowledge of field conditions are important to economical and efficient blasting in quarrying, coal mining, metal mining, and construction.

HERCULES POWDER COMPANY
INCORPORATED

Explosives Department, 932 King St. Wilmington 99, Del.
Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Cal.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Cal.

XR53-9

World's Tunnelling Record



(Top left) M-K Co. of Canada & B.C. International Engineering officials. (l to r) Jake Smith, master mechanic, J. K. Black, resident engineer for B.C.I.E., R. E. "Whitey" Davis, general underground superintendent, Ray Reed, area engineer, H. W. Morrison, president of Morrison-Knudsen Company, Inc., R. H. Madsen, assistant project manager, W. Hostetter, tunnel superintendent, J. P. Growdon, consulting engineer, W. Bear, walking boss, Patty O'Dowd, walking boss, John McNamara, shift boss, M. Bellehumeur, shift boss, C. Chase, shift boss, A. O. Strandberg, project manager, G. Griffin, district manager for M.K, and S. L. Williams, night tunnel foreman.

(Top right) 2600' level at Kemano. Some of the drillers, muckers and helpers who established the first world's record advance for a tunnel of this size (25' bore) in this heading.

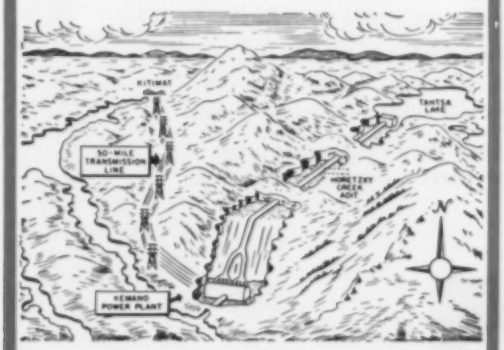
Horetzky Champions — graveyard shift of Morrison-Knudsen rock drillers on the Horetzky to Tahtsa (East) heading. Both the Horetzky (East and West) headings were under the supervision of V. Bland, superintendent and C. McClellan, assistant superintendent.

Some of the men who advanced the Horetzky-Kemano (West) heading 282 feet in six working days.

broken **FIVE TIMES** on Alcan B.C. Project

M-K ALCAN TUNNELLERS DRIVE 248, 258, 261, 274 AND 282 FEET OF FULL BORE HEADING IN SIX DAYS.

The ten mile bore in British Columbia will carry water from the impounded Tahtsa Lake area through the Coast Range mountains to the huge Kemano underground power plant. Water will drop 2600 feet through underground penstocks to generate electric power for the aluminum smelter at Kitimat, 50 miles distant. Part of the half-billion "Alcan" Project of the Aluminum Company of Canada, Limited, this development will add tremendously to the economic production and wealth of North America.



During the week ending September 29th, 1952, Canadian drilling crews of the Morrison-Knudsen Company of Canada, Limited, drove 248 feet of 25-foot diameter horseshoe bore in six days at the Kemano-Horetzky heading. This eclipsed the previous record of 241 feet of 24′ tunnel, made by M-K tunnellers at the Big Creek number 4 dam in California in 1949.

In October and November the Kemano crews shattered their own records by driving 258 feet, then 261 feet in six day periods.

At the end of November the Alcan aces topped their previous footage by driving 274 feet at the Horetzky-Tahtsa (east) heading near the midway point of the tunnel.

In the week ending February 21st, 1953, the M-K Alcan crews at the Horetzky-Kemano (west) heading set a new mark by driving 282 feet of 25′ bore in six days.

These records for high speed tunnelling were all made with Ingersoll-Rand DA-35 Power Feed Drifters with 48″ aluminum shells, using 1¼″ lugged round steel and 2″ Carset Tungsten Carbide Detachable Jackbits.

Yesterday's records are commonplace today. Today's reports of average weekly footages often equal yesterday's record performances. For example, during a period of 72 days (12 — 6 day weeks) the crews at Kemano averaged close to 40 feet of 25′ bore per day. At midsummer 1953 about 32,000 feet of the 53,000 total had been driven with DA-35 Drifters and Carset Bits at the Kemano and East and West Horetzky headings.

FAST RAISE DRIVING

Fast time was also made in driving the 48 degree 5′ x 10′ pilot raises for the penstocks inside the mountain from the powerhouse, intersecting the tunnels or adits on the 1600 and 2600 foot levels. Driven with CR-58 Stopehamers and 1¾″ Type 1 Carset Jackbits, footages, including time required for handling men, material, timbering, drilling, blasting and mucking, ranged from 132 to 138 feet of raise per six day week. The powerhouse excavation (700′ x 80′ x 120′) was under the supervision of Charles Swartz, and the raise driving was directed by A. Ostergard.

IR CANADA

Canadian Ingersoll-Rand Company Limited

HEAD OFFICE · MONTREAL, QUE. — WORKS · SHERBROOKE, QUE.

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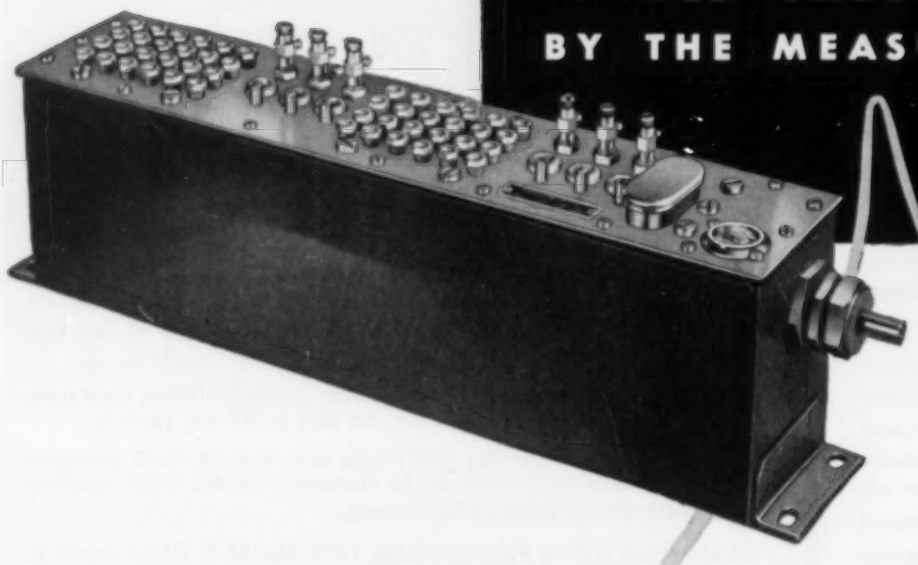
MADISON-KIPP *Fresh Oil*

. . . FED UNDER PRESSURE BY THE MEASURED DROP



the most dependable method of lubrication ever developed!

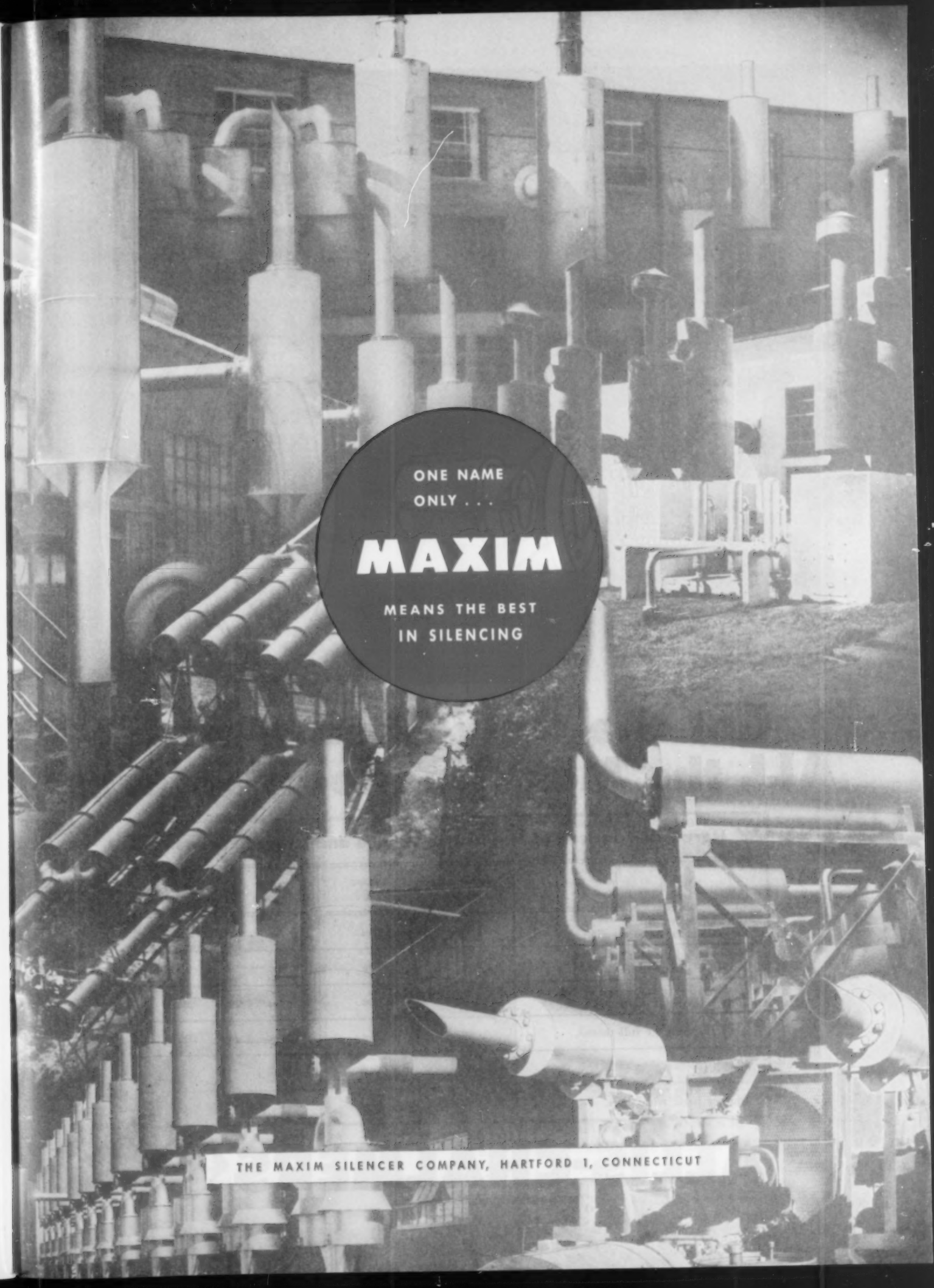
This lubricator becomes an integral part of a machine tool in which there are 48 vital bearings that require dependable lubrication. The Madison-Kipp mechanism is so compact that the reservoir measurements are only 4" wide, 19¾" long by 5¾ high."

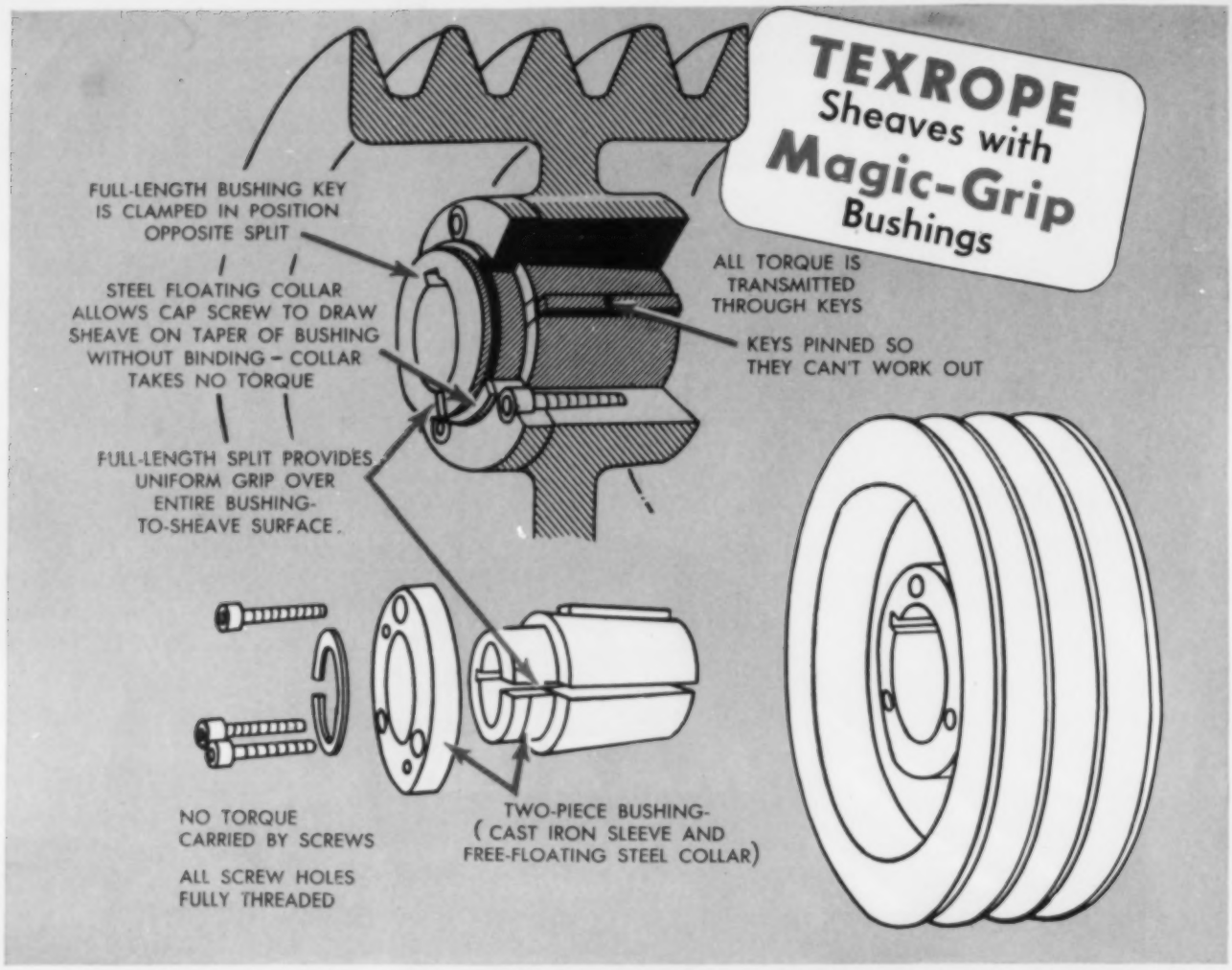
There are six different models to meet almost every application requirement. Please write us for all details regarding your particular lubricator requirements.

MADISON-KIPP CORPORATION
202 WAUBESA STREET • MADISON 10, WISCONSIN

kipp

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools


ONE NAME
ONLY . . .
MAXIM
MEANS THE BEST
IN SILENCING
THE MAXIM SILENCER COMPANY, HARTFORD 1, CONNECTICUT


TEXROPE
Sheaves with
Magic-Grip
Bushings
FULL-LENGTH BUSHING KEY IS CLAMPED IN POSITION OPPOSITE SPLIT
STEEL FLOATING COLLAR ALLOWS CAP SCREW TO DRAW SHEAVE ON TAPER OF BUSHING WITHOUT BINDING – COLLAR TAKES NO TORQUE
FULL-LENGTH SPLIT PROVIDES UNIFORM GRIP OVER ENTIRE BUSHING-TO-SHEAVE SURFACE.
ALL TORQUE IS TRANSMITTED THROUGH KEYS
KEYS PINNED SO THEY CAN'T WORK OUT
NO TORQUE CARRIED BY SCREWS
ALL SCREW HOLES FULLY THREADED
TWO-PIECE BUSHING- (CAST IRON SLEEVE AND FREE-FLOATING STEEL COLLAR)

Get the Only Sheave with ALL the Most Needed Features

Here's Comparison of *Magic-Grip* Sheave and Other Sheaves

	Magic-Grip Sheaves	SHEAVE A	SHEAVE B	SHEAVE C
Bushing fully split for uniform clamping action.	Yes	Yes	No	Yes
Load carried by keys instead of threaded bolts.	Yes	No	No	No
Bushings cover full range of NEMA "probable" shaft diameters.	Yes	Yes	Yes	No
All screws engage full thread.	Yes	Yes	Yes	No
Mounts in one piece.	Yes	No	Yes	Yes
Squares itself with shaft.	Yes	No	No	No

A-4167

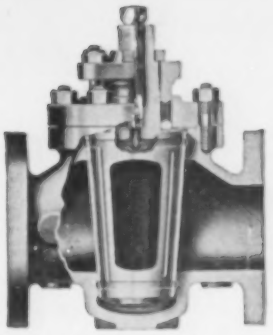
Texrope and *Magic-Grip* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

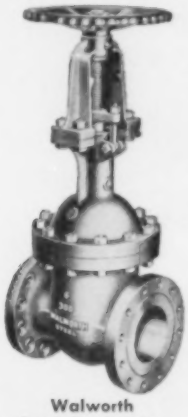
MILWAUKEE 1, WISCONSIN

● VALVES

● PIPE FITTINGS

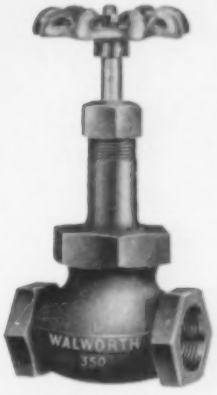


Walworth
Lubricated Plug Valve



Walworth
Steel Gate Valve

Walworth
Iron Body Gate Valve



Walworth
"500 Brinell" Bronze Globe Valve

Walworth
Iron Body Saddle Gate Valve

Walworth
Cast Steel Flanged Fittings

Walworth manufactures a *complete line* of valves and pipe fittings: all made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties. In design, construction, and performance, Walworth products reflect more than a century of experience in the manufacture of quality valves and fittings.

Your Walworth distributor will give you full information on the *complete line* of Walworth steel, iron, and bronze, and special alloy valves and pipe fittings; also Walworth Lubricated Plug Valves, and Walseal* valves, fittings and flanges. Ask for this information today.

*Patented—Reg. U. S. Pat. Off.

WALWORTH

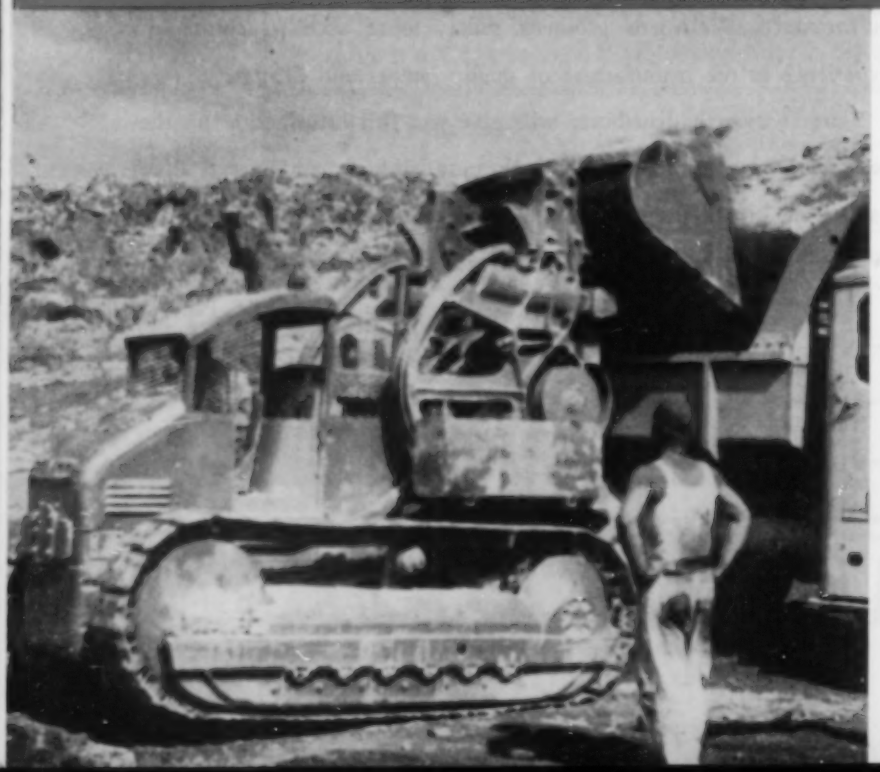
valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

EIMCO

WORLD'S FINEST TRACTOR EXCAVATOR

The 105 at work excavating semiconsolidated material. The machine shown here is on a contract job and is equipped with a 1½ cubic yard bucket equipped with long digging lip and teeth. The extra heavy design of this unit provides the necessary strength to use the machine for actual excavation work. Speed in loading is governed by the travel distance to the truck. With trucks in close the Eimco 105 can easily load at the rate of 6 to 8 yards per minute. Below—The operator sits up front in the 105 where he can get the best view of the work. Discharge of the bucket is controlled by the operator through the Eimco two speed bucket transmission.



Yes! The Eimco 105 is the world's finest tractor excavator! This is the first unit ever designed and built from the ground up with the purpose of performing as a base for heavy-duty attachments to its own frame so that it could be used efficiently for handling many jobs in addition to hauling around other equipment. The 105 is designed for heavy shock vertical loads as well as normal loads imposed through straight drawbar pull.

The Eimco 105 operates freely under all loading conditions, will dig, excavate or bulldoze on even or uneven ground because of its full oscillating track feature even with the bucket attachment.

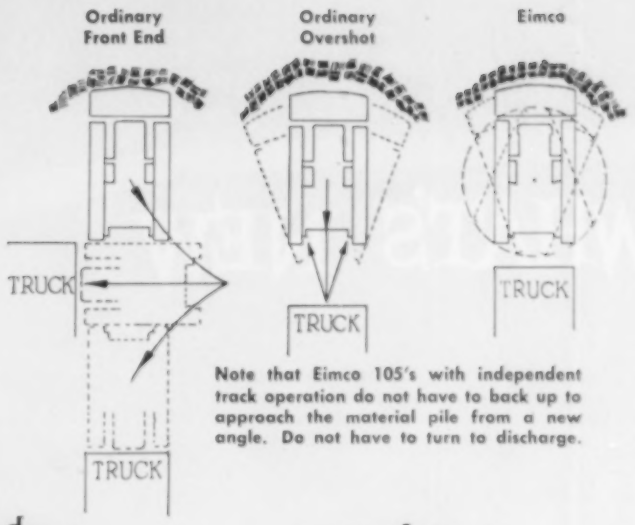
WITH COST SAVING ADVANTAGES

SAVES TIME: Simple, conveniently located handles held in one hand control all movements. Push for forward — pull for reverse — twist for spin turns. This easy control simplifies the operator's work — eliminates turning to dump — eliminates foot clutches and hand shifting and pull brakes — keeps the trucks up close and speeds up the loading cycle.

GREATER DEPENDABILITY: Simple, strong construction of the great new Eimco transmission provides greater dependability. This compact unit contains all of the gearing and clutches for speed changing and full independent reversal of each track. Every moving part is pressure lubricated. The oil-cooled, positive engagement clutches never need adjustment.

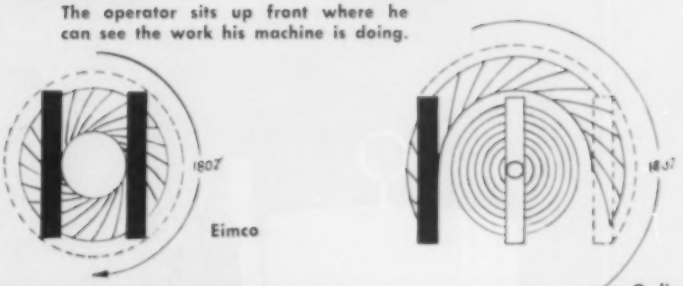
BETTER VISABILITY: The operator in the Eimco 105 sits up front where he can see the work that's being done.

GREATER FLEXIBILITY: The 105 covers the upper bracket range of work done by several models of ordinary tractor equipment in several different price and weight brackets. With the 105 priced with the lower of this group, yet powerful enough to do many of the jobs for which the larger, more expensive, units are employed.



Note that Eimco 105's with independent track operation do not have to back up to approach the material pile from a new angle. Do not have to turn to discharge.

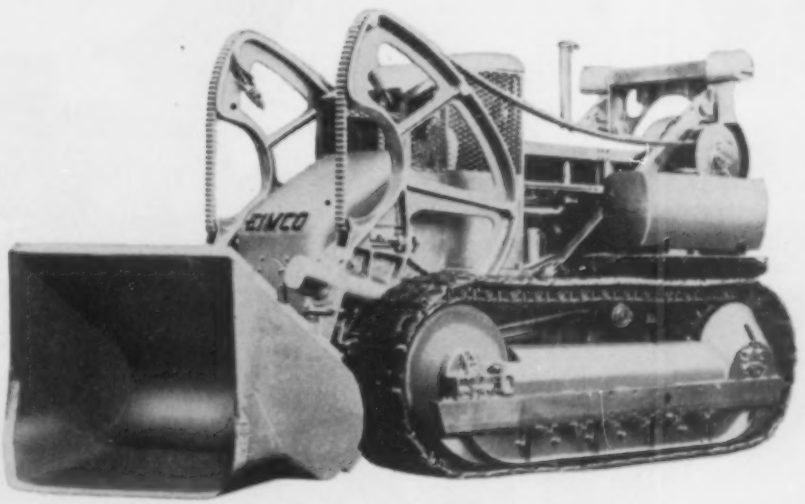
The operator sits up front where he can see the work his machine is doing.



Note: Eimco turns in its own length — makes "spin turns." Ordinary tractors lock one track and walk around.

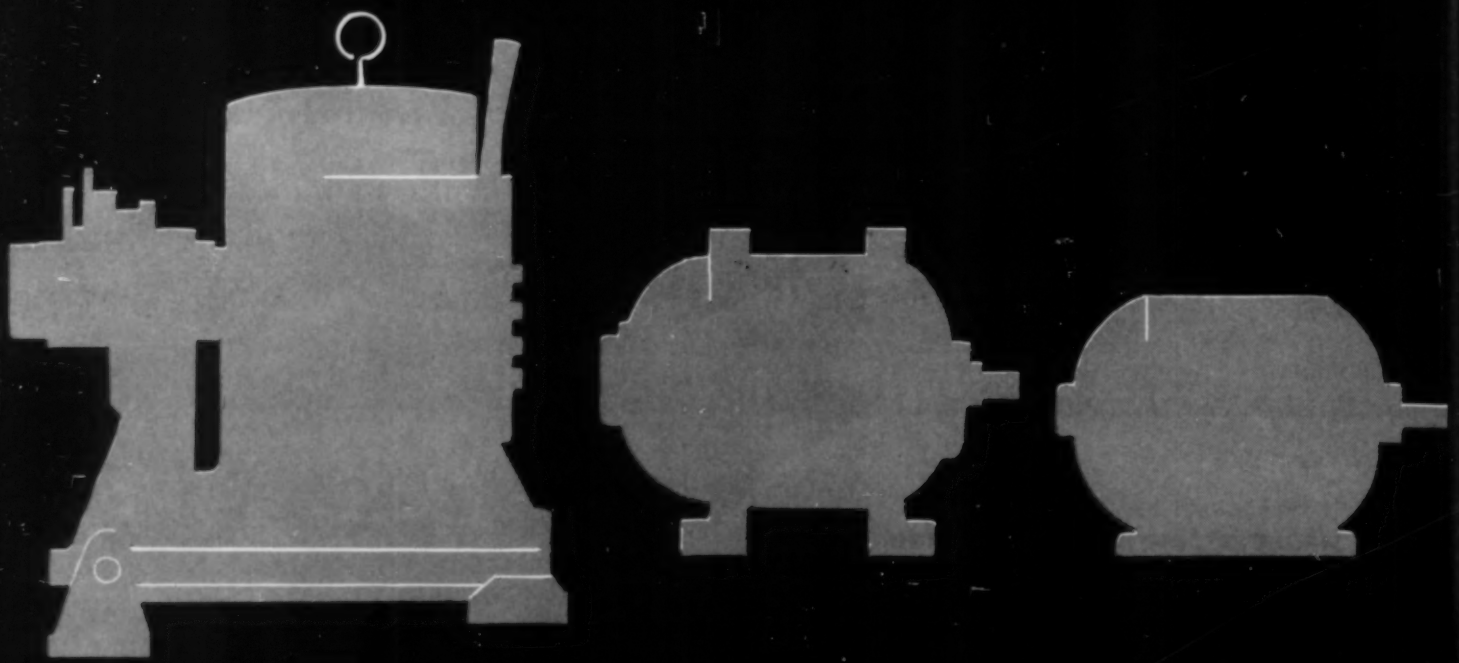
THE EIMCO CORPORATION
Salt Lake City, Utah, U.S.A.
Export Office: Eimco Bldg., 52 South St., New York City

STRONGER CONSTRUCTION THROUGHOUT: The 105 is made of steel — not cast iron. There is quite a difference in these two construction materials. Cast alloy steel as used in the 105 is not subject to shock cracks even under severe operating conditions. Steel stands strains and stresses imposed by heavy loads without danger of failure. The Eimco 105 is the only crawler unit made of steel and gives you a superior machine with longer dependable life and lower maintenance costs. This is the machine for your next heavy job. Let us send an Eimco engineer to tell you the facts.



The Eimco 105 — world's finest tractor-excavator

WHAT'S NEW IN MOTORS



1888
TESLA
5 H.P.
765 LBS.

1926
C5
5 H.P.
130 LBS.

1947
LIFE-LINE
5 H.P.
119 LBS.

IS STILL TO COME . . .

Hear anything about a new motor? Well, if you think you have, let's set the record straight . . . What's New In Motors Is Still To Come!

Westinghouse has been a leader in the designing and manufacturing of motors for over 60 years. During these many years, over 20 million dollars has been spent on the development of basic lines of induction motors to maintain this leadership. Here are the real years of "new motors" in the parade of progress:

1888—*THE FIRST A-C MOTOR—THE WESTINGHOUSE TESLA MOTOR*

1926—*THE FIRST SEALED SLEEVE BEARINGS—THE WESTINGHOUSE CS MOTOR*

1947—*THE FIRST MOTOR WITH PRE-LUBRICATED BEARINGS PLUS A ⅓ WEIGHT AND SIZE REDUCTION—THE WESTINGHOUSE LIFE-LINE MOTOR*

The smaller, lighter Westinghouse Life-Line Motor of 1947 was the last major contribution. *AND FOR THE NEXT ALL-IMPORTANT STEP AHEAD IN MOTOR PROGRESS . . . LOOK TO WESTINGHOUSE.*

YOU CAN BE SURE.. IF IT'S Westinghouse

J-21834

THE ONLY MODERN FRONT END ... ON QUARRY SHOVELS

110-B, 4½ cu. yd.
150-B, 6 cu. yd.
190-B, 8 cu. yd.

Convertible Shovels — Draglines

THE new Bucyrus-Erie Ward Leonard electric shovels bring to quarry loading the first important departure from the old-fashioned shovel front end. This advanced design — with two-section boom, inside tubular handle, and quiet positive rope crowd — increases speed and payload. It reduces upper boom weight, puts extra strength in the lower section where maximum strength is needed. It cuts out old-style handle racking and crowd pinions, takes the deadweight of crowd machinery off the boom. And, most important to *you*, it gives you all these field-proven performance advantages:

- **Lighter Weight, Greater Strength** — Two-section boom, with light upper section . . . lower section strut-connected to the A-frame.
- **No Handle Twist** — Inside tubular dipper handle is free to rotate in rubber-cushioned saddle block.
- **No Handle Binding in Saddle Block** — Rope crowd is quiet, positive, eliminates handle racking and crowd pinions.
- **No Dipper Wobble** — Twin dual hoist ropes put hoist power where needed for steady travel of dipper through bank.
- **No Sway Braces** — Widespread boom feet eliminate accessory boom braces or cables.
- **Low Swing Loads** — Advanced front end design, with crowd machinery on deck, cuts dead load on swing, steps up swing speed.
- **High Pay Loads** — Single tubular handle — with improved dipper back connections, dipper trip on saddle block, no dipper bail — reduces dead load on hoist, leaves more power for digging.

311-53C

There's much more to the story, too. Deck machinery, electrical equipment, and mounting all match the front end in advanced engineering and outstanding performance advantages. The full story will convince you that yard for yard, dollar for dollar, pound for pound, these are the finest rock excavators ever built.

Write for Complete Information Today!

BUCYRUS ERIE

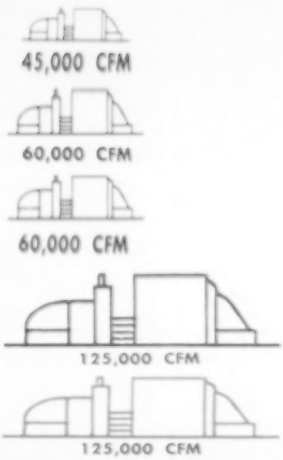
BUCYRUS-ERIE COMPANY SOUTH MILWAUKEE, WISCONSIN

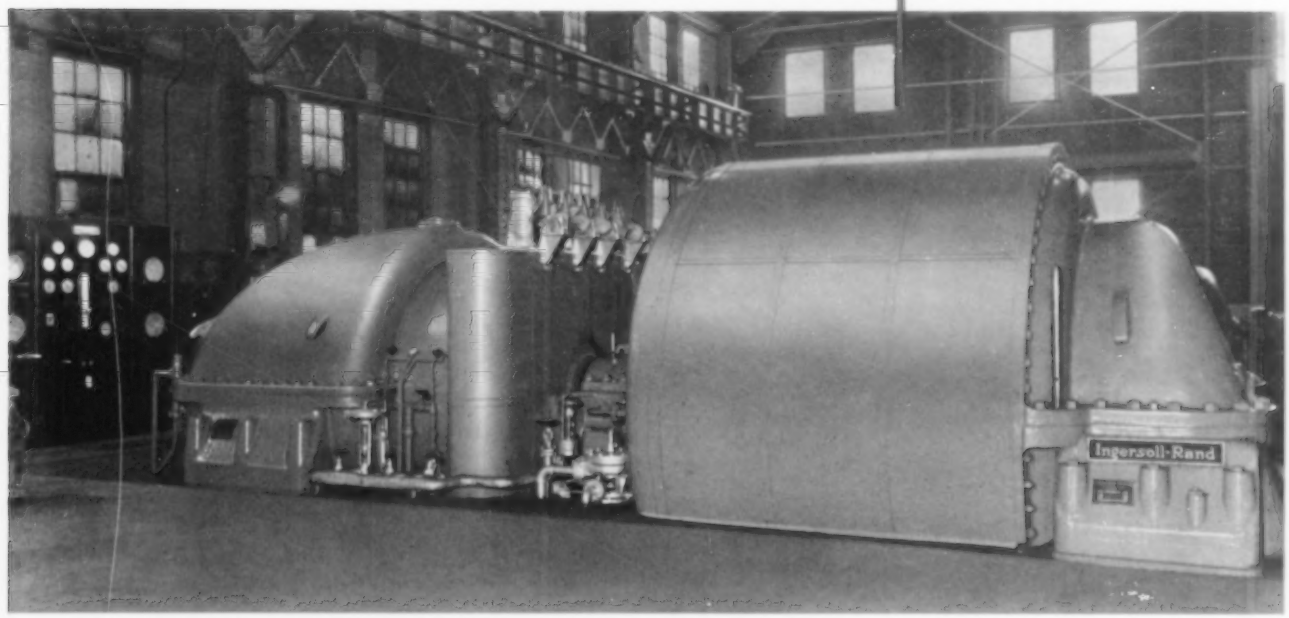
Youngstown Sheet and Tube Company

installs ITS FIFTH

I-R BLAST-FURNACE BLOWER

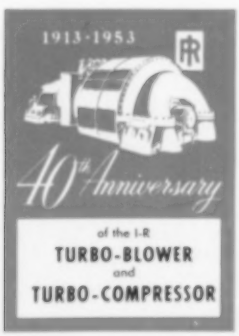
at Indiana Harbor Plant





The first I-R Blast Furnace Turbo-Blower installed at Indiana Harbor is still in daily service after 36 years of operation.

Six additional Blast Furnace Blowers in other Youngstown Sheet and Tube Co. plants bring the total to 11 units representing 760,000 cfm capacity.



PAST EXPERIENCE is one sure way of predicting future performance.

That's why the Youngstown Sheet and Tube Company continues to select I-R blast furnace turbo-blowers with *complete confidence* in their ability to give years of continuous, trouble-free service. For this steel company knows what I-R blowers can do — based on 36 years of actual operating experience. The first I-R blast furnace blower at the Indiana Harbor plant was installed in 1917 — and it's still on the job today.

The last two I-R Turbo-Blowers installed at Indiana Harbor, each rated 125,000 cfm, 35 psi discharge, are served by Ingersoll-Rand condensers, condensate pumps and circulating water pumps. Other Ingersoll-Rand equipment includes air compressors for plant air supply, instrument air and soot blowing, boiler-feed pumps and many other pumping units for miscellaneous plant service.

For proved *dependability* in steel mill equipment, it pays to specify Ingersoll-Rand. Your nearest I-R representative will be glad to discuss your requirements.

Ingersoll-Rand

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COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

How TIMKEN® bearings help prevent kinks in high-speed chain production

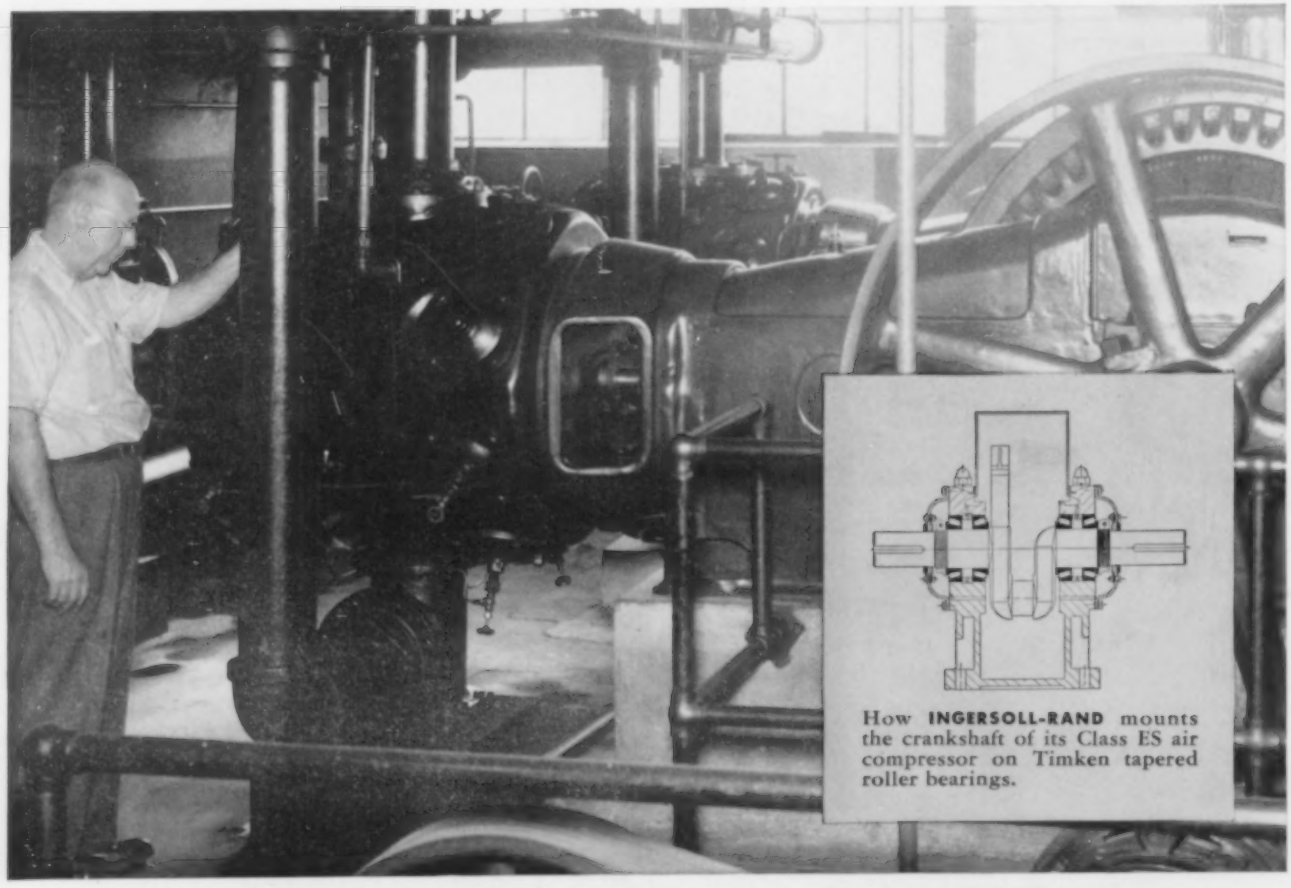
IN making bead chain, jets of compressed air are used to clear the chain from the dies of high speed presses. The Ingersoll-Rand Class ES compressor, below, supplies air for the job without costly breakdowns and maintenance delays. One big reason: Timken® tapered roller bearings on the compressor's crankshaft.

The tapered construction of Timken bearings lets them take radial and thrust loads in any combination. The crankshaft is held in positive alignment, holding down wear on adjacent parts. Crankshaft wear is eliminated because there is no friction between it and the bearing.

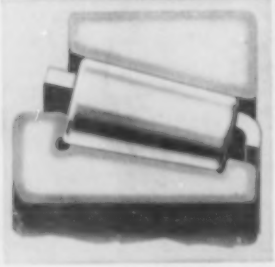
More power is delivered by the crankshaft, less is lost in the bearings because the true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction. And Timken bearings hold housings and shaft concentric, making closures more effective. Lubricant is kept in—dirt and moisture are kept out.

Be sure you specify Timken bearings in the machinery you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **INGERSOLL-RAND** mounts the crankshaft of its Class ES air compressor on Timken tapered roller bearings.



HARD ON THE OUTSIDE, TOUGH ON THE INSIDE

Rollers and races of Timken bearings are case-carburized to give a hard, wear-resisting surface and a tough, shock-resisting core. Result: longer bearing life.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

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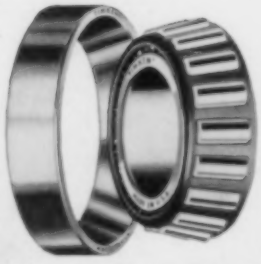
TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬮ AND THRUST →⬮← LOADS OR ANY COMBINATION →✳←